CHEESE MAKING

A Book for Practical Cheesemakers, Factory Patrons, Agricultural Colleges and Dairy Schools

BY

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MADISON, WISCONSIN

Tenth Edition, Revised and Enlarged

ILLUSTRATED

Published by
THE CHEESE MAKER BOOK CO
Madison, Wis.
1942

U. S. CHEESE PRODUCTION AND CONSUMPTION

Excepting Cottage, Pot, and Baker's Cheese

From U. S. D. A., B. A. E. Tech. Bul. 722, and D. S. 114.

From the Agricultural Marketing Service, U.S.D.A.

Year	Production	Total Supply	Population July 1 (Census)	Consumption Total	Consumption Per capita	Year
	1,000 lbs.	1,000 lbs.	Thousands	1,000 lbs.	Pounds	
1909	320,581	354,307	90,691	349,734	3.86	1909
1910	364,623	404,054	92,267	400,413	4.34	1910
1911	357,059	400,782	93,682	385,826	4.12	1911
1912	336,974	383,652	95,097	379,385	3.99	1912
1913	374,669	429,091	96,512	452,565	4.41	1913
1914	385,743	438,628	97,928	434,156	4.43	1914
1915	457,311	496,445	99,343	432,174	4.35	1915
1916	437,248	465,164	100,758	409,323	4.06	1916
1917	485,667	491,978	102,173	436,863	4.28	1917
1918	405,605	482,150	103,588	401,665	3.88	1918
1919	481,702	519,314	105,003	438,635	4.18	1919
1920	436,852	515,661	106,543	444,850	4.18	1920
1921	428,453	504,855	108,208	448,273	4.14	1921
1922	437,632	524,358	109,873	470,993	4.29	1922
1923	458,452	563,431	111,537	484,749	4.35	1923
1924	472,046	597,146	113,202	521,450	4.61	1924
1925	496,406	624.728	114,867	535,420	4.66	1925
1926	475,362	625,707	116,532	544,215	4.67	1926
1927	449,444	602,096	118,197	529,481	4.48	1927
1928	481,227	625,505	119,862	532,294	4.44	1928
1929	487,200	650,966	121,526	560,599	4.61	1929
1930	500,367	654,405	123,091	567,446	4.61	1930
1931	492,379	635,561	124,113	553,537	4.46	1931
1932	484,103	615,122	124,974	542,917	4.34	1932
1933	543,735	661,193	125,770	565,719	4.50	1933
1934	579,122	718,047	126,626	612,007	4.83	1934
1935	620,956	771,414	127,521	668,131	5.24	1935
1936	642,551			687,712	5.35	1936
1937	648,997			712,282	5.51	1937
1938	724,574			759,255	5.83	1938
1939	703,421	Preliminary			5.87	1939
1940	783,814	Preliminary			5.88	1940

CHEESE MANUFACTURES IN THE UNITED STATES, 1940

Excluding Cottage, Pot and Bakers'

State	(000 omitted)
Maine	-------
New Hampshire	-------
Vermont	1,938
Massachusetts	1,375
Rhode Island	21
Connecticut	167
New York	59,754
New Jersey	1,880
Pennsylvania	10,940
North Atlantic	**76,075**
Ohio	21,425
Indiana	29,486
Illinois	47,801
Michigan	18,195
Wisconsin	406,903
E. North Central	**523,810**

State	(000 omitted)
Delaware	43
Maryland	7
Virginia	61
West Virginia	158
North Carolina	400
South Carolina	221
Georgia	30
Florida	-------
South Atlantic	**920**
Kentucky	5,989
Tennessee	14,473
Alabama	939
Mississippi	6,987
Arkansas	3,225
Louisiana	208
Oklahoma	7,574
Texas	18,641
South Central	**58,036**

State	(000 omitted)
Minnesota	16,166
Iowa	4,024
Missouri	19,677
North Dakota	-------
South Dakota	982
Nebraska	1,417
Kansas	10,979
W. North Central	**53,245**
Montana	1,282
Idaho	13,256
Wyoming	1,658
Colorado	2,292
New Mexico	674
Arizona	512
Utah	4,507
Nevada	16
Washington	10,158
Oregon	21,488
California	15,885
West	**71,728**
United States	**783,814**

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Manufactured in the
United States of America

PREFACE

Practical cheese makers, and dairy school students, find described in this book modern methods for making many kinds of cheese of commercial importance, on a large scale, at any factory or creamery. In many cases, the same methods can also be used with small amounts of milk, as at a dairy goat farm, etc.

The first edition of "Cheesemaking" was published in 1893 by Prof. J. W. Decker, for use in the first American Dairy School, established in 1891 at the Wisconsin College of Agriculture. The distinguished success of the book both in the English and in a French translation by Emile Castele for French-Canadian cheesemakers, is a lasting tribute to the memory of its original author. The work was revised and enlarged by Professor Decker for three later editions. After his death it was again revised by Dr. F. W. Woll, one of Professor Decker's colleagues at the University of Wisconsin.

The book was rewritten and enlarged by the present author in the editions of 1918, 1924, 1930, 1937, and the tenth edition in 1942.

Part 1 treats subjects of general importance to all cheese factory men, such as milk production and inspection, factory planning and operation, cheese judging, whey cream, business management, methods of payment, standardization, pasteurization, clarification, costs, cheese composition and yield, etc.

Part 2 classifies cheese varieties, and in its successive chapters decribes practical mthods used in the manufacture of cheese varieties of commercial importance in America. The regular development of the subject, proceeding from the simplest methods to the more complex, affords the most satisfactory basis for a general survey of the industry, during the school work of a year or half year. Every maker should know several kinds of cheese.

In a school, the term's work may begin with chapter 1 (Part 1) in the classroom, and at the same time chapter 20 or 21 or 22 (Part 2) in the work room. The numbering of sections in bold faced type, the enlarged index and selected references facilitate study.

The complete exhaustion of all previous editions affords an opportunity for bringing the volume up to date, to meet the needs of practical cheesemakers and factory managers, and dairy school students.

Acknowledgment is due for the loan of cuts by the Wisconsin Experiment Station; the Marschall Dairy Laboratory of Madison, Wis.; Stoelting Bros., Kiel, Wis.; Brillion Iron Works, Brillion, Wis.; Creamery Package Mfg. Co., Chicago, Ill.; Damrow Bros., Fond du Lac, Wis.; Kimble Glass Co., Chicago; Cherry-Burrell Corporation, and many others.

J. L. SAMMIS.

Madison, 1942.

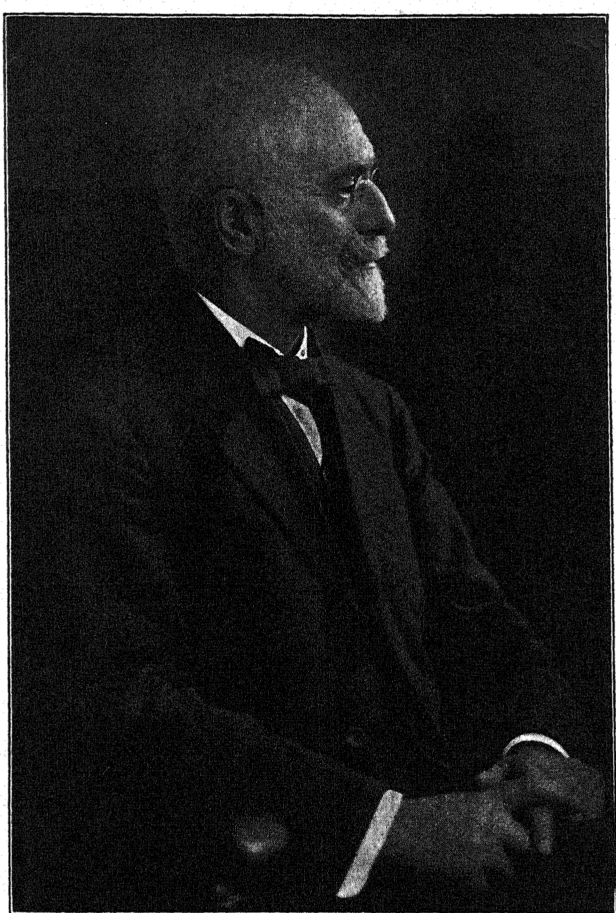
To the Memory of

STEPHEN MOULTON BABCOCK, Ph. D., Sc. D.

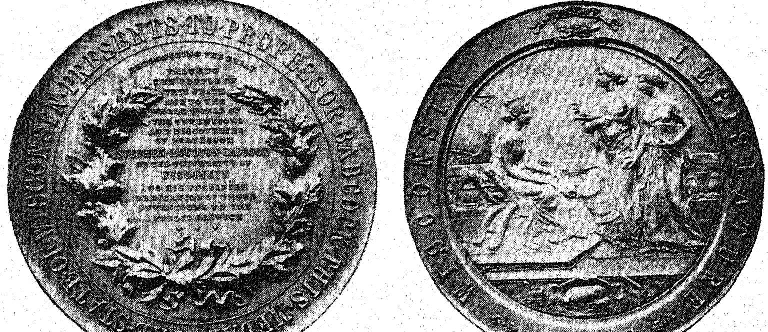
Chief Chemist of The Wisconsin Experiment Station

Who as a teacher, and later as a co-worker, by patient labor and wise counsel, inspired the author with a greater love for the profession of dairying.

THIS BOOK IS INSCRIBED



DR. STEPHEN MOULTON BABCOCK



Medal presented to Dr. Babcock by Wisconsin legislature in 1899.

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PART I.

GENERAL FACTS FOR CHEESEMAKERS

CHAPTER I.

The Cheesemaker's Education

(1) Aims. While working in a cheese factory, or Dairy School, the young or old cheesemaker tries to learn (1) the best practical way to perform each of the many different operations in a day's work, and the reasons for each operation; (2) he learns the timing, that is, how to judge when the milk or curd is ready for the next step in the process, and why the timing differs from day to day. Also, (3) he will want to learn to make more than one kind of cheese, and several ways to do each operation, because different factories have different equipment, or emergencies may arise when the regular equipment can not be used, or special methods may be necessary in making cheese, as described in Part II. In addition, he will learn about the organization, planning, equipment and cost of a factory, testing milk, cheese and whey, doing business with farmer patrons and with cheese buyers, buying supplies, keeping records, clean milk production, etc., as described in Part I.

(2) Sources of Information. At the Dairy School and at conventions are gathered people from all parts of the country, from large and small factories, where different methods of making are used. By getting well acquainted and talking often with each other, students may learn much.

Dairy papers, giving the cheese markets, factory and trade news, are published in New York, Chicago, Wisconsin, Michigan, Minnesota, Iowa, California, Canada, New Zealand, etc.

Books in the agricultural library in English, French, German, Danish, Spanish, Italian, etc., describe methods and products.

A dairy society, or a local cheesemakers association, meeting regularly to discuss cheesemaking topics and other subjects, is of great value, also affording practice for organizing and conducting meetings of factory patrons.

State laws relating to cheese, milk, etc., or printed lists of cheese factories located in any state, can usually be obtained by writing to the Dairy and Food Commissioner, at the capitol city of that state.

Bulletins on subjects related to the cheese industry issued from the U. S. Department of Agriculture, (or a list of them) can be obtained on request sent to the Superintendent of Documents, Government Printing Office, Washington, D. C. Bulletins from any leading dairy state can be obtained by addressing that Agricultural Experiment Station, at its post office, named in the list of states below.

Alabama—**Auburn**
Alaska—**College**
Arizona—**Tucson**
Arkansas—**Fayetteville**
California—**Berkeley**
Colorado—**Fort Collins**
Connecticut—
(New Haven) Station: **New Haven**
Storrs Station: **Storrs**
Delaware—**Newark**
Florida—**Gainesville**
Georgia—**Experiment**
Hawaii—**Honolulu**
Idaho—**Moscow**
Illinois—**Urbana**
Indiana—**La Fayette**
Iowa—**Ames**
Kansas—**Manhattan**
Kentucky—**Lexington**
Louisiana—**University**
Maine—**Orono**
Maryland—**College Park**
Massachusetts—**Amherst**
Michigan—**East Lansing**
Minnesota—**University Farm, St. Paul**
Mississippi—**State College**
Missouri
College Station: **Columbia**
Montana—**Bozeman**
Nebraska—**Lincoln**
Nevada—**Reno**
New Hampshire—**Durham**
New Jersey—**New Brunswick**
New Mexico—**State College**
New York
State Station: **Geneva**
Cornell Station: **Ithaca**
North Carolina—**State College Station, Raleigh**
North Dakota—**State College Station, Fargo**
Ohio—**Wooster**
Oklahoma—**Stillwater**
Oregon—**Corvallis**
Pennsylvania—**State College**
Rhode Island—**Kingston**
South Carolina—**Clemson**
South Dakota—**Brookings**
Tennessee—**Knoxville**
Texas—**College Station**
Utah—**Logan**
Vermont—**Burlington**
Virginia—**Blacksburg**
Washington
College Station: **Pullman**
Western Station: **Puyallup**
West Virginia—**Morgantown**
Wisconsin—**Madison**
Wyoming—**Laramie**

(3) The Student's Duty. Be prompt at all times. Pay close attention so as not to need to be told twice. Write down all that is new to you, because

(1) facts often are presented too fast to be remembered,
(2) writing them down helps one to remember,
(3) written notes can be reviewed later.

Study hard. Think for yourself. Ask questions.

Just as you have a daily schedule of work, arrange for yourself a plan for daily study. Take a short brisk walk out of doors daily and a long walk at least once a week, for your health. Eat moderately. Sleep with windows open.

"Personal cleanliness is of the first and highest importance with factory operators. Keep your body clean and your mind clear. Dirt and ignorance cost the dairy industry millions of dollars annually. Each student should take a thorough bath at least once a week. There is no excuse for lack of cleanliness. See that your underclothes as well as your overalls are always clean through frequent changes. Each morning before appearing in the class room, the student will give his hands and finger nails special attention and in all respects be in suitable form for

creamery and cheese factory inspection. In general, we hope in our Dairy School to teach not only how to make butter and cheese but to inculcate habits of great personal neatness, and an intense desire to have everything about the factory clean, tidy and in business form."—(From "Advice to Students" by Prof. E. H. Farrington.)

(4) Experience in Many Lines. In a commercial factory, the helper is sometimes kept busy upon a narrow line of work, as washing hoops or cans, and has little chance to learn other parts of the work. At the dairy school, instruction is given in all parts of the work.

The maker in a factory should prepare himself to give advice to his patrons on many subjects connected with dairy farming, factory business, etc.

Co-operation the Key to Success. The prosperity of any factory depends equally upon the maker and the farmers and on their friendly co-operation. The maker, if he has the right spirit, will strive not only to make good cheese and keep his factory clean, but also to be a friend and leader to his patrons in their part of the work. "Let him that would be greatest among you be the servant of all." By such means the material success of the factory is promoted, and at the same time those harmonious relationships among men are established which are the foundations of civilization and the building stones of our American republic.

CHAPTER II.

Production and Care of Milk on the Farm

(5) Importance of Clean Milk for Cheese. Clean milk is especially necessary for cheese manufacture, because nearly all of the bacteria and dirt in the milk are retained in the cheese curd. In making cream or butter, most of the dirt and bacteria in the milk go out in the skim milk or buttermilk.

To get the best quality of cheese, the milk should go into the cheese vat in the same fresh, clean condition as when it came from the udder of a normal, healthy cow.

The good starter put in by the cheesemaker adds to the milk the right kinds of bacteria, which will live and grow in the curd and cheese, and help to develop fine flavor and quality. By excluding harmful "barnyard" bacteria, bad flavors and other defects may be avoided. Every maker should expect, by his efforts, to have his patrons produce a cleaner, better milk supply next year. (Extension Bul. 192, State Col. of Washington) (S. Dakota Circ. 22.)

The maker can tell the farmer (1) that with defective milk there is sure to be a loss either in the yield or quality of the cheese, and (2) that the laws in most dairy states prohibit the sale or delivery of any insanitary milk at the factory, under penalty of fine and imprisonment.

The farmer aims (1) to detect abnormal or unhealthy cows, and to keep their milk out; (2) during the milking and cooling, to keep out of the milk all dirt and dust so far as possible (because of the harmful bacteria contained in dirt) by clean methods of milking, including clean cows, stables, hands, pails, strainers, and cans, and by keeping cans covered; (3) to prevent further growth, in the milk, of any bacteria which may have fallen in by accident, by prompt cooling to the temperature of well water, using a thermometer and not guessing at the milk temperature, and by continued cold storage until delivered at the factory. (4) Friendly cooperation among maker and patrons should bring all the milk at a factory up to a high standard of quality. (Wis. Bul. 189; N. Y. (Geneva) Bul. 398; Baltimore Health Dept. Bul. 1.)

(5A) Healthy Cows. Any cow in poor physical condition, either from disease or lack of proper feed, is likely to produce less milk and less cheesemaking solids, or sometimes defective milk which curdles poorly with rennet, or otherwise is abnormal in composition. Hence the importance of state wide eradication of tuberculosis, Bang's disease, etc. (Vermont Bul. 382.)

Garget (or mastitis) means a feverish udder. This condition may be severe or slight, temporary or sometimes incurable. The temporary cause may be a blow from the milker's boot, an injury in the barn or at a fence, or exposure to cold, etc., or the cause may be some kind of bacterial infection brought to the udder through the blood or through cracked teats. When of bacterial origin it may be carried from one cow to another on the milker's hands, or on bedding. In a number of cases, whole herds have become infected, and finally were so unprofitable, that they were sold to the butcher at a loss. Any milker can detect a feverish, swollen, lumpy, condition of the udder.

The "strip cup" is a small cloth strainer, often made at home, to be carried to the barn with the milk pail. The first streams of milk from any quarter are run through this strainer, to detect the presence of particles of white curd, which indicates garget. Tests repeated daily may show that the condition soon disappears; or it may continue and spread throughout the herd. To prevent such spread, the sick cows are milked last, and may be segregated from the herd. Cleanliness is imperative.

Garget milk is also frequently more or less alkaline than normal milk. This condition is detected by the veterinarian, by applying one drop of milk to a strip of paper colored with bromothymol blue or other indicator. Upon drying the paper, the spot of abnormal milk shows a color change.

Alkaline milk curdles very slowly with rennet, or often not at all. If the herd milk curdles slowly, it is likely that some cows in the herd may have garget.

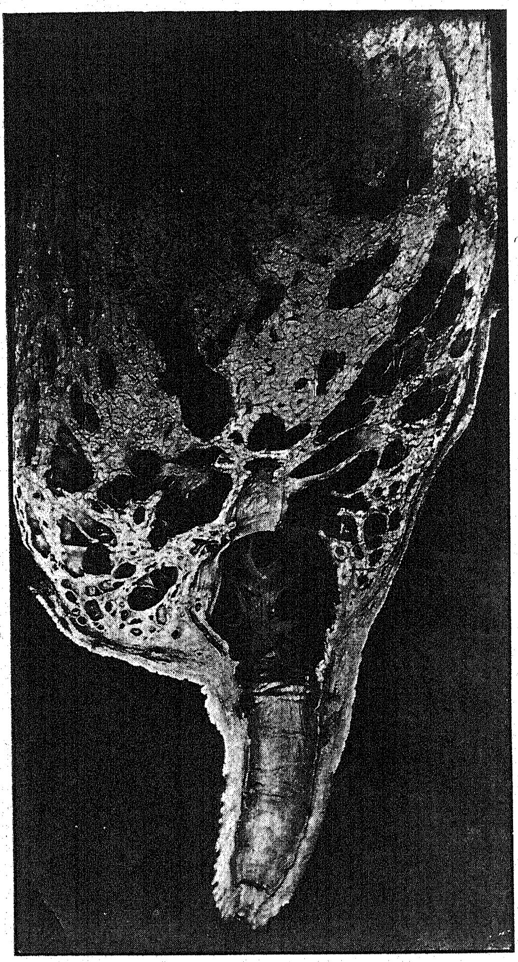
The cheesemaker who discovers a white slime in the vat strainer may put a cloth strainer over his weigh can, and thus observe which patrons deliver milk containing this indication of garget. The farmer seeing this in his milk should use the strip cup at his barn, to learn how many and which of his cows show this white, slimy curd and, if the condition increases or is wide spread, he may consult the veterinarian.

The presence of a small amount of garget milk in a vat does not appear to injure the flavor or quality of the cheese, although it may reduce the yield. (See Wis. Cir. (1935) by F. B. Hadley; Penn. Univ., Vet. Ext. Quart. No. 45 (1932) pp. 4-6; New York (Geneva) Tech Bul. 199; S. Dak. Bul. 290; Mich. Ext. Bul. 165.) N. Y. Tech. Bul. 242 (1937).

(5B) Testing Cows for Garget. Based on the finding that a certain kind of bacteria (Streptococcus agalactiae) is generally present in milk from any quarter or udder affected with garget, the Hotis test has been devised for laboratory use.

In a sterile test tube, 9.5 c.c. of the milk sample from the suspected quarter or udder is mixed with .5 c.c. of a .5% water

solution of brom-cresol purple, and placed in an incubator at 37.5 C. (100 F.) for 24 hours. With sweet milk the color of the mixture is deep purple, changing to blue-gray, olive, yellow-green, and finally to yellow as the milk acidity increases. In



A section through a quarter of a cow udder. From a photograph (Cornell Univ. Experiment Station).

addition, if S. agalactiae are present, small flakes or balls of growth form on the side of the tube, composed of milk curd and entwined chains of these bacteria. Ranging in size from a pin point to 1/6 inch, these spots are of a canary yellow color, surrounded by a halo of the same color, merging into the darker

color of the milk, and thus clearly visible. When the tube of milk ripens very slowly, a second 24 hours incubation may be necessary to develop the yellow color, but if flakes are present in 24 hours, no further test is needed. The Hotis test is described in Circular 400, U. S. Dept. of Agric., sold for 10 cents by the Supt. of Documents, U. S. Govt. Printing Office, Washington, D. C.

Milk from mastitis-infected cows yields good quality large eyed Swiss cheese after clarification. This effect seems to be connected with the removal of leucocytes, which are abundant in garget milk. (1936 Rept. Bur. Dairy Ind. p. 7) (Ontario Dept. Agr. Bul. 381.) (204)

(5C) Ropy Milk. This fault is due to excessive growth of certain bacteria, and indicates lack of cleanliness in care of milk, cans, strainers, water supply, whey tanks, or other details.

(5D) Soft Curd Milk Trouble. At unexpected times, often during dry weather, the vat of milk may suddenly begin to curdle poorly with rennet, requiring a longer time for thickening, or remaining soft and mushy, and difficult to cut evenly. The trouble may continue, or disappear soon.

The push required to drive a curd knife through a curd can be measured exactly by use of a curd-o-meter, a small curd knife to which pressure is applied by adding weights, or by means of a spring attachment instead of weights. Utah Circ. 101; Pa. Bul. 312; Geneva, N. Y. Tech. Bul. 242. The number of grams required is a measure of the "curd tension," and is 50 to 80 grams for cow herd milk, and averages over 100 grams for goat milk, but may be zero to 30 grams for soft curd milks.

The only definite and outstanding difference in composition between soft-curd milk (33 grams or less) and hard-curd milk (60 grams or more) is that the soft-curd milks are low in casein. Such milks, of course, give low cheese yields.

Milk from infected udders gives lower curd tension values than would be expected from the casein content.

Curd tension is reduced by dilution of milk with water, up to dilutions of 30-40%. Variations in curd tension occur, due to the season; and the lactation period, being highest the first month or six weeks, lowest in the second month, then gradually increasing to a second high, close to the end of the lactation period, when it may finally fall to zero. Utah Bul. 236.

Discussing experiments in making cheese from soft-curd milk, it is stated in Tech. Bul. 242 (1937) (N. Y. Geneva Station) that "the milk used in the experiments, authough not abnormal in appearance, would not set an acceptable curd with rennet unless a starter (or hydrochloric acid) was added. When

milk of the type used in this study is to be made into cheese, the importance of using a Marschall cup test or some similar test before setting the milk is apparent. Milk of the type selected for these experiments can be employed for cheese making with acceptable results by using 1½ to 3% of starter. It is imperative, in using this amount of culture, to have a starter that is clean, active, and of very high quality. Even though an acceptable cheese can be made by use of an increased amount of starter from the type of milk used in these experiments, it is recommended as important that mastitis be eliminated insofar as possible from herds supplying milk for cheese making." The use of hydrochloric acid was not recommended, for a factory.

(6) Sources of Trouble to Avoid. Odors. Milk absorbs odors easily from the air, and to a greater extent if the milk is warm, during the milking of cows in an unventilated or uncleaned barn, or if cans of milk are left over night in any room or shed where there is a noticeable odor. Thus, when a can of winter milk was left over night in the farm kitchen with the lid off and taken after breakfast to the cheese factory, the cheesemaker could smell the sausage, pan cakes and coffee that the farmer had for breakfast.

Where silage is fed during milking, the milk often acquires a silage odor from the air of the milking room. Modern barns are commonly built with a ventilation system and a manure conveyor to facilitate daily cleaning. Every milk can has a cover intended to be used to keep out dirt, odors, etc.

Wild Onions. When harvested with hay, these weed pests can cause their ruinous flavor to be noticeable during the winter.

Difficulty is seldom experienced if dairy cows are grazed on pastures infested with wild onions for only 2 or 3 hours immediately after milking and then kept in a clean pasture or paddock 5 or 6 hours before the next milking.

(6A) Dirt and Bacteria. Bacteria are present in the soil, in flying dust, in the barn yard, and especially in manure. A thimble full of dry manure contains more bacteria than there are people on the whole earth (about two billion). It is very important to keep manure dust out of milk.

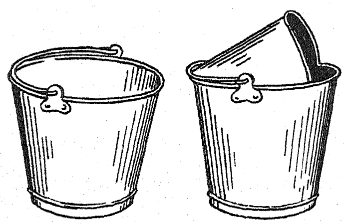
When a particle of soil or a lump of dried manure falls into milk, (1) a part of it dissolves, as sugar dissolves in coffee, and of course the dissolved flavor can never be removed by straining the milk; (2) a large part of the lump consists of live bacteria, which are solid particles and do not dissolve, but they are so very small that they can go through the best farm or factory strainer; (3) the lump may also contain grains of sand, hair, chaff, flies, or other coarse, insoluble particles which are large enough to

settle rapidly, and can be strained out easily on any good milk strainer, either at the farm or the factory.

Of these three, the dissolved flavor and the coarse dirt do not grow in the milk, because they are not alive. The bacteria are alive, and will grow in numbers in warm milk.

(6B) Clean Hands. The milker should have clean hands, by washing and drying the hands before milking. A shower bath of simple construction at the dairy barn or cheese factory facilitates cleanliness.

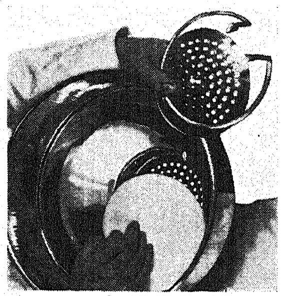
(6C) Pails and Cans. Smooth, bright metal surfaces are always easiest to clean. Tin pails are smoother and generally cleaner than galvanized. Open seams are impossible to clean, and should be flushed with solder. Battered or rusty tinware is very hard to clean and should be rebuilt, retinned, or replaced. Holes should be soldered, not stuffed with a rag. Milk tins should be washed clean twice a day, drained, and kept in a clean place until the next milking. Unclean utensils are a frequent cause for defective milk. A closed top pail excludes three fourths of the falling dirt. (N. Y. Geneva Bul. 317, 326; Va. Bul. 185; Farmers Bul. 135.)



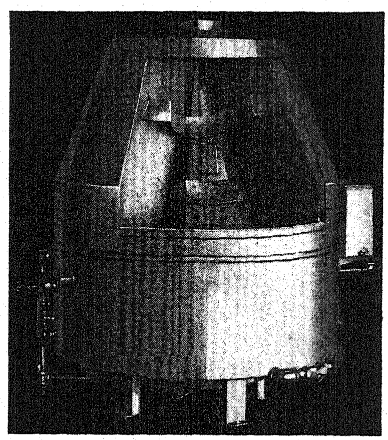
Closed top pails can be purchased from dealers, or made by any tinsmith. See that all seams are well filled with solder.

Tin ware is best cleaned by first, rinsing promptly with cold water; second, scrubbing with warm water and washing powder (not soap) and a good stiff, clean brush ((not a rag); third, rinsing with clean water but not wiping inside; fourth, leaving them open, upside down in a clean, dustless place to drain and dry. Do not locate the can rack in a dusty barn yard. To get a can really clean inside, it is necessary finally to free it from bacteria. The hot water available on the farm is seldom sufficient in quantity or temperature to sterilize anything thoroughly. For this reason, and also because the rinse water, even if fresh from the well may often contain harmful bacteria, it is well to add a good chlorine disinfectant to the final rinse water just before using the utensils.

(6D) Strainers. The more dirt the milker sees on the strainer, the surer he feels that the strainer has made the milk clean. He overlooks the dissolved flavor and the bacteria, which no farm milk strainer can take out of milk. He may overlook the fact, also, that the ordinary cloth milk strainer in many cases is not washed thoroughly clean, or if washed is hung up to dry on the clothesline in the yard, where the dust from the road and barnyard or fields again fills it with dirt and bacteria. When he uses this strainer at the next milking, he overlooks the fact that such a strainer, while it takes out coarse dirt, also adds large numbers of barnyard bacteria to the milk, so that the strainer cloth becomes cleaner and the milk becomes dirtier because the strainer was used in this manner.



Cotton Pad Milk Strainer.



Rotary Milk Can Washer.

The old time farmyard cloth strainer often did more harm than good. The best modern strainer with a fresh cotton pad for each milking is far better. New and improved large sized strainers for use at cheese factories are on the market.

It is often possible to learn from the experience of older neighbors. In Switzerland, for many years, it has been the habit, established by printed rules, that in no case shall milk be strained at the farm, but always first strained at the cheese factory intake, for the manufacture of Swiss cheese. (Praktische Anleitung zur Fabrikation und Behandlung des Emmenthalerkaeses, by Prof. A. Peter, Director, Swiss Dairy School, Rutti-Zollikofen. Third edition, 1914, sixth edition, 1930.) Under this plan the maker can see how clean each patron was in his work each day. Milk producers should put more reliance on cleanliness and thorough cooling of milk at the farm than upon any farm straining process. (6F)

Bacteria are smaller than fat globules in milk so that any strainer which could take out bacteria must also take out the fat. (Vermont Bul. 341; Bul. No. 1 of the Baltimore City Health Department.)

(6E) Clean Cows and Stables. Dirt adhering to a cow's udder falls into the milk during milking. Much of this can be prevented by clipping the hair short around the udder, and by cleaning or at least wiping the udder with a cloth each time before milking.

Barns and barnyards should be maintained in such condition that the cows can keep themselves reasonably clean. Cows should not wade through a muddy barnyard, or lie down in a filthy stable. A cement gutter, a cement block just outside the barn door, and a concrete floor under a shed roof along side of the barn are helpful.

Large factories and many condensaries and city milk buyers wash, steam, and dry all patrons' cans as soon as emptied, and require the use of a different set of cans for hauling back the whey, etc. Steaming whey in the factory whey tank helps greatly in keeping the milk supply clean.

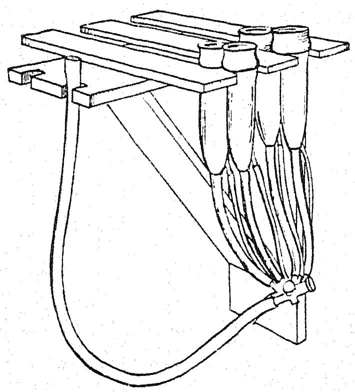
In the room where cows are milked, there should be neither dust falling from the ceiling, nor a wet, muddy floor underneath, nor a foul smell in the air. A well lighted and ventilated stable, whitewashed once or twice a year, is most satisfactory, and is a source of pride to the milker. Plenty of light helps to kill germs in the barn, and to keep cows in good health.

Dusty feeds, as hay, and strong smelling or strong flavored feeds as silage should be fed just after milking rather than just before. Some feeds, as cabbage, rape, turnips, green corn, green barley, and some weeds, as leeks or wild onions, impart flavors to milk in the udder if the cow eats them within one, two, or three hours before milking. (U. S. D. A. Buls. 1097, 1190, 1208, Circ. 276, Wis. Bul. 115, Farmers Bul. 608.) (Cal. Bul. 595.) Silage or brewers grains, carelessly handled before milking may infect the milker's hands strongly with the bacteria and yeasts they contain.

Milk is secreted to a large extent at the time of milking, since the udder has room for only a small portion of the milk yielded by a cow at a milking. When a cow is excited, she may fail to produce as much milk of the same quality as usual. (Jour. Dairy Sci. May 1928.) (U. S. Jour. Agr. Research 1932, p. 385.) Sudden changes in feed may affect a cow's health, cause looseness and get cow and dairy barn dirty. Drinking cups in stalls permit cows to drink freely and have been shown to increase milk flow. (Tech. Bul. 278, Oct. 1931.)

(6F) Milking Machines. Milking machines have several advantages. The owner of a large herd finds that they save time and labor, with less hired help required than when milking by hand. The milk in the machine is not exposed to the air of the barn during milking. Dirt from the cow's udder or the milker's hands is kept out. Complaints in the past from cheesemakers about the quality of milk were based mainly on lack of proper cleaning of the machines by the older methods then in use. The ten gallon jars for chlorinated water, in which milking machine tubes were kept, have been found by the writer at numerous farms to contain no chlorine disinfectant, and hence to be useless.

The newer method of disinfecting the tubes and teat-cups is cheaper and is far less likely to be neglected. The rubber parts are rinsed with cold water immediately after milking, and are then hung up with both ends at the same level, with the middle hanging in the form of a U from a home made wooden rack. They are then filled with a dilute lye solution made at home as follows. To one gallon of water (soft water if available) in a crock or wooden pail, empty a 13 ounce can of ordinary lye, costing 10 of 15 cents. Stir with a stick until dissolved, and put this strong lye solution into a gallon jug with a good stopper. Mix thoroughly 1/3 pint of this strong lye solution with water enough to fill a 1 gallon jug for daily use. Keep it corked, and use it to fill up the tubes and teat-cups hanging on the rack. (Ind. Bul. 348; Wis. Circ. 259.)



Home-Made Rack for Teat Cup Assembly.

This lye solution will not injure the rubber, but will (1) kill all bacteria present, (2) dissolve any particles of curd or casein, and (3) loosen any butter fat in the rubber tubes, and thus clean them well.

Before the next milking, empty the tubes, and rinse them with pure well (or chlorine disinfected) water. If not rinsed, they will slip off of the teats. Some makers steam the milking machine parts frequently for their patrons. Modern machines are not injured by such heating.

(6G) Cooling and Holding Night Milk. From the moment milk leaves the cow's udder, it begins to deteriorate by infection with bacteria from cans, utensils, and surroundings, and by rapid growth of these bacteria in the warm milk. Cooling is done to delay and, so far as possible, to stop the bacteria from growing and increasing in number in the milk. If morning milk must be hauled a long distance (and time) it should be cooled on the farm. Where milk is delivered twice a day, it may be cooled, or delivered fresh and warm without any delay after milking.

Morning milk, not cooled, hauled on routes for several hours, is often seriously damaged by growth of bacteria.

A safe rule is that milk should either be delivered to the factory within one hour after milking or else promptly cooled to the temperature of well water, and then kept cold until delivered.

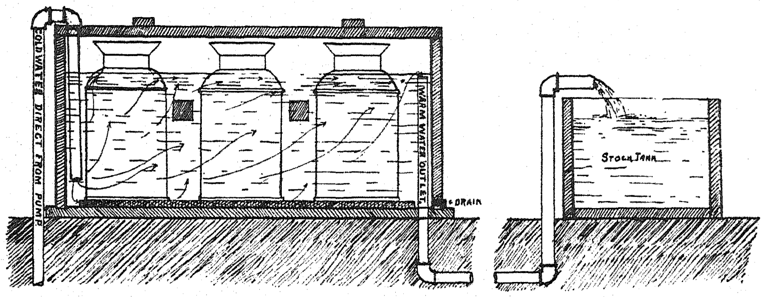
For quick cooling of milk, a tin cooler or tubular cooler, filled with running well water, is very effective, but for storage of the cooled milk, a cold water tank is also necessary. As the tank can be used both for cooling and for storage, the use of the tin cooler for cheese factory milk is limited, by reason of its cost and the extra work of keeping it clean. (Farmers Bul. 602-976.)

As a means for cooling milk, and also storing it over night, a concrete, wooden or galvanized cooling tank, having a hinged cover, and conveniently connected between the farm pump and the stock watering tank is most common. A water barrel for house water supply may be put in the line, also. Some farms have spring water. A milk house built over the tank protects washed milk cans from dust, but should not be used as a general store room. (Farmers Bulletin 976.) Makers should warn patrons early each spring to put their cooling tanks in order before the first warm nights occur, to avoid a lot of overripe night milk. (Neb. Bul. 133; Purdue Bul. 188; Vermont Bul. 343.)

With the cans of milk standing in the cold water tank, the old practice was to stir each can with a dipper, each time a pail of milk is brought in. Finally pump in fresh well water, stir well, and put the lids on tight.

(6H) The "Cold Spot" Plan. Instead of buying a separate cooling tank as described above, a small section of the stock tank, next to the pump, may be partitioned off, thus making a "cold spot" cooling and storage space at little or no cost, as described

in 1934 in a Wisconsin leaflet by the writer. Many farmers have built this with success. A wooden walled tank keeps out the heat better than galvanized. A wooden cover over the "cold



Tank for cooling milk (after Frandsen).

spot" is always necessary to protect the milk and the cooling water from the hot summer sun and air. Also, instead of leaving the cans uncovered, and stirring the milk with a paddle or dipper, is is now recommended to put on the milk can cover immediately when full, set the can in the cold water, and hasten the cooling of the milk by rocking the can of milk in the tank of water, thus stirring both the milk and the water, each time when bringing up another pail of milk. The milk cools faster by this method, and the flying dust and the dirty paddle or dipper are kept out of the milk. It is also recommended that a common glass dairy thermometer be used to show when the cooling water needs changing, and when the milk is fully cooled. Quit guessing at milk temperatures. Well water temperature is about 52 degrees in Wisconsin, and about 47 degrees in summer in the Michigan Upper Peninsula. (Mich. Quart. Bul. Feb. 1935, p. 159.)

Other Methods. The old-time aerator never can cool milk sufficiently in warm weather, but is likely to cause milk to take up dust and bad odors. Under ordinary farm conditions the aerator is likely to do more harm than good. Never mix warm milk with cold milk on the farm. Freezing milk is likely to increase the loss of fat in the whey. (Mo. Bul. 256.)

A few makers have preferred to cool the warm night milk over a tubular cooler at the factory, and hold it cold over night for use next morning.

Cork insulated water tanks, cooled by small refrigeration units electrically operated, are advertised for cooling night and morning milk at the farm, where the cost of electric current is low. (Pa. Bul. 375 (1939) Farmers Bul. 1818.)

(7) Pure Water Supply. The pioneers usually could get pure water from a shallow, dug well, suitable for washing milk

cans, etc., as well as cold enough for cooling milk. At present, these old dug wells are found often to be contaminated with seepage and sewage soaking through the ground considerable distances from barn yards, outhouses, etc., so that the water is no longer fit for washing cans, or for use at a cheese factory. Some factories which formerly made good cheese, have later produced poor flavored cheese and were about to be closed, when examination of the water supply from the dug well showed it to be impure. Installing a new, deep, drilled well immediately corrected the trouble. Pure water supply is essential both at dairy farms and factories. (89A)

At the factory, pure water may be obtained by catching condensed steam from a leaking pipe joint or valve. In an emergency, when impure well water is found to be the cause of defective milk or cheese, each pail of water may be disinfected before use by stirring in a little chlorine disinfectant. This may be used safely for diluting rennet, or for final rinsing of vats and utensils. The vat pan may also be steam heated to disinfect it after washing, and should then be kept covered until next used. A clean vat cover is a necessity in every factory.

(8) Variation in Quality of Milk. At any factory, there is likely to be a daily variation in the quality of milk, due to various causes, affecting the individual or the group.

Accidents by which dirt falls into milk may happen at one farm or another, any day. One or another patron may fail to wash utensils with the usual care, because of occasional illness, extra work, circus day, picnics, or other disturbing factors.

Weekly lapses in care and cleanliness, due to haste, may occur on Sunday or Saturday nights, when the help desires to get away early. Poor milk next morning results.

As warm weather approaches, or farm work becomes more pressing, or in very hot, dry or rainy weather, an increase in the proportion of poor quality milk delivered is often noticed. A small amount of inferior milk may sometimes be put into a large vat of good milk without seriously injuring the selling price of the cheese, but unless milk is carefully inspected daily, a large proportion of the farmers may begin gradually to neglect cleanliness, until finally the factory is producing inferior cheese daily, and the maker may be discharged, or outside help may be called in to clean up the milk supply, test the well water, insist on steaming whey, or locate other neglected sources of trouble. It pays to watch the milk supply closely. Some day milk may be graded at factories. (U. S. Dept. Agric. Circ. 294.) (Bul. 257, N. Y. Dept. Agric. and Mkts.) See 17G.

Occasional vats of gassy cheese may be due to occasional failure at a farm to wash cans, etc. Repeated gassy cheese, day

after day, may be due to unwashed milking machines (6F), lack of cooling at the farm (6G), whey tank infected with yeast or gas bacteria (220), or to a starter which looks good but contains gas bacteria (33).

(8A) Cooling Most Neglected. The dirt that falls into milk during milking is measured by the sediment test, and removed by means of the strainer, but in many regions patrons have very poor cooling facilities in use.

By rapid reproduction in warm milk, the bacteria that FELL in during milking can INCREASE their number 100 times in four hours, or 1,000 times in six hours (18) after milking.

If 99% of the bacteria in a vat GREW in uncooled milk cans during the night, from the 1% that FELL in during milking, COOLING is far more important than STRAINING. Practically every can of off flavored milk has not been properly cooled. Thermometers used, instead of guessing, at the farm, the milk truck, and the intake will show the facts.

CHAPTER III.

Inspection and Tests of Milk at the Intake

(9) Reasons for Inspection. The reasons for careful daily inspection of milk at the factory are (1) that any defective milk may be detected before it enters the cheese vat, and be separated, or sent back to the farm with advice or instructions to the farmer as to how he may avoid such trouble next time. Proper attention to this is part of the maker's duty and protects careful patrons from having their good milk mixed with defective milk from a careless patron. It also protects both maker and patrons from possible prosecution and fine by official inspectors visiting the factory and finding that unfit milk is being offered and accepted.

(2) Another important reason for inspection is that it gives the maker, at the earliest possible moment, a knowledge as to what kind of milk he has today, so that he may handle it to the best advantage. Do not leave this to the helper.

(3) Careful daily inspection of milk impresses the patrons with the importance of handling milk properly at the farm, and sets them a good example. Smell every can of milk. (Milk Dealer (1935) (30-66.)

(10) To Prepare for Milk Inspection. Intakes should be built so that the maker and patron can examine, sample and smell every can of milk before it is poured into the weigh can, and make such other tests as desired. Some factories, (199) especially the Swiss, brick and Limburger factories, were not so built. Intake inspection by the cheesemaker should include, first, his own equipment and outer clothing, to see that his overalls, weigh can, strainer, conductor and vat are in fit condition, before the patrons come.

(11) Inspection Arouses Interest in Quality. The intake room is the place where, for a few minutes each day, the farmer and the cheesemaker work together in privacy and give attention to the milk supply, as to quality, quantity, etc. Here the maker has the opportunity to build up in the farmer's mind an interest in cleanliness and cooling, teach him the facts (chapter II), and perhaps conduct a cleanliness contest among the patrons by use of the sediment test, or a cooling contest by use of the thermometer test on the night milk. The results of such contests are good material to present at a meeting of the factory patrons.

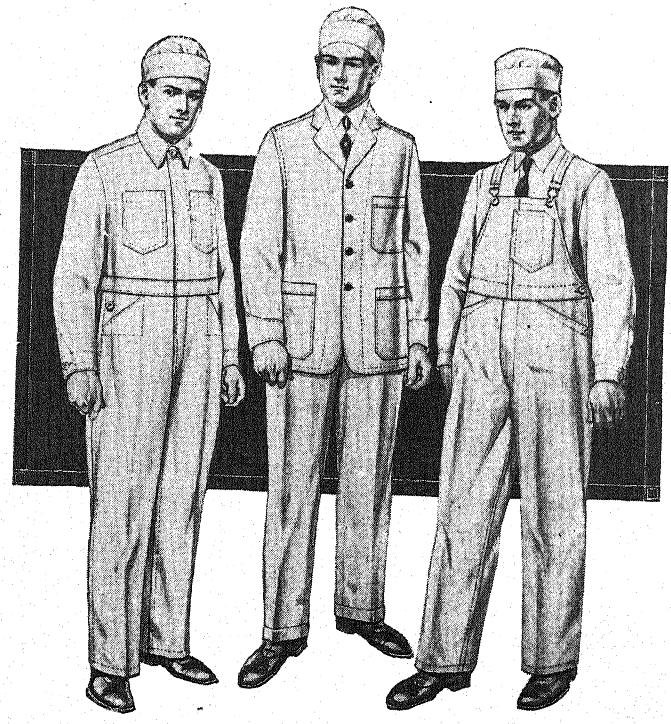
(12) Inspection for Today's Work at the Vat. At the intake the maker may observe:

(1) the temperature, color, odor, taste, the presence of dirt in the milk, or in the bottom, sides or shoulder of the can, or on the can, wagon, or hauler,

(2) undue ripeness or acidity in milk,

(3) unfit milk due to sick cows, garget, colostrum, added preservatives, or milk that will not curdle with rennet,

(4) harmful treatment, boiling, skimming, watering,



(5) presence of harmful bacteria or yeast which may injure the cheese, by causing gas, bad flavor, etc.,

(6) proportion of fat, casein, or solids not fat, to detect adulteration, or serve as the basis of payments to patrons.

(12A) Methods of Milk Inspection at the Intake.

(1) The appearance of wagon and hauler are good indications of farm conditions, under which the milk was produced. Rusty, worn out cans are seen and condemned at once. By touching the can surface, the temperature may be judged and the maker can tell whether night and morning milk have been

mixed in one can. The "thermometer test" may be applied to the cans of night milk.

As soon as the can is uncovered, notice the odor at once. Milk stored over night in a stable, pig pen, or kitchen, etc., often shows strong odors absorbed from the air in these places.

While emptying, the inside and bottom of the can are observed. Unwashed cans often show a ring of dried milk around the inside. Look for grease under the shoulder.

When the can is nearly empty, if dirt is seen, the maker may tip the can back and keep the dirt out of the vat. The use of the sediment test at irregular intervals has proved a great help.

(2) If milk smells overripe, an acidimeter or rapid acid test may be used to show the patron quickly the overripe condition, if he can not smell it.

(3) A cloth strainer over the weigh can shows the patron any coarse dirt in the milk, and any white curd due to garget or sick cows, etc. Bloody milk should be rejected. Colostrum curdles on boiling, and should be kept out of the cheese vat. Ropy milk indicates high bacterial content.

(4) The milk of some cows curdles poorly with rennet at times, due to garget or other causes, and such milk may be useless or harmful in cheesemaking. Rennet tests on herd milks or individual cows are sometimes made when milk in the vat or kettle thickens poorly (50B).

Preservatives are rarely used but may be detected readily by laboratory tests.

The lactometer may be floated in the weigh can to detect gross watering or replacement of skim milk by water, and samples of suspected milk may be taken in pint jars to be tested more closely, later in the day, by the lactometer (17C).

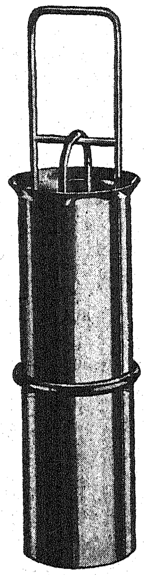
(5) Methylene blue tests, curd tests or fermentation tests on each patron's milk in separate well scalded jars, jelly glasses or test tubes are made to find which patron is bringing infected milk causing gassy or tainted cheese (17).

(6) Composite samples of milk kept with a preservative tablet in tightly stoppered bottles are tested for fat at most factories twice a month to serve as a basis of patron's payments, and in connection with the lactometer test (17C) to detect watering or skimming. A sampling tube or a dipper may be used. The tube is more accurate, but harder to clean.

(13) Friendly Advice and Other Means. The friendly maker can often secure improvement in milk quality when defective by advice given privately to the patron at the intake, or by a visit to the farm. In case of stubborn refusal to improve conditions, the maker should notify the officers or other patrons

of the factory, whose influence may be sufficient, but if necessary the facts should be sent to the Dairy and Food Commissioner, whose inspectors have authority to bring offenders into court, and to secure the infliction of fines or imprisonment as provided by law.

(15) The Sediment Test. This useful test, long used in Europe, was first brought to the notice of American cheesemakers, in Wisconsin bulletin 195, in 1910. In the European test, a



The Vacuum Sediment Test.

pint of milk runs by gravity through a cotton filter disc in about 15 minutes.

In its improved American form, the test can be applied to milk as fast as delivered at the intake, finishing each patron's milk test immediately so that he can see it, in comparison with those previously taken.

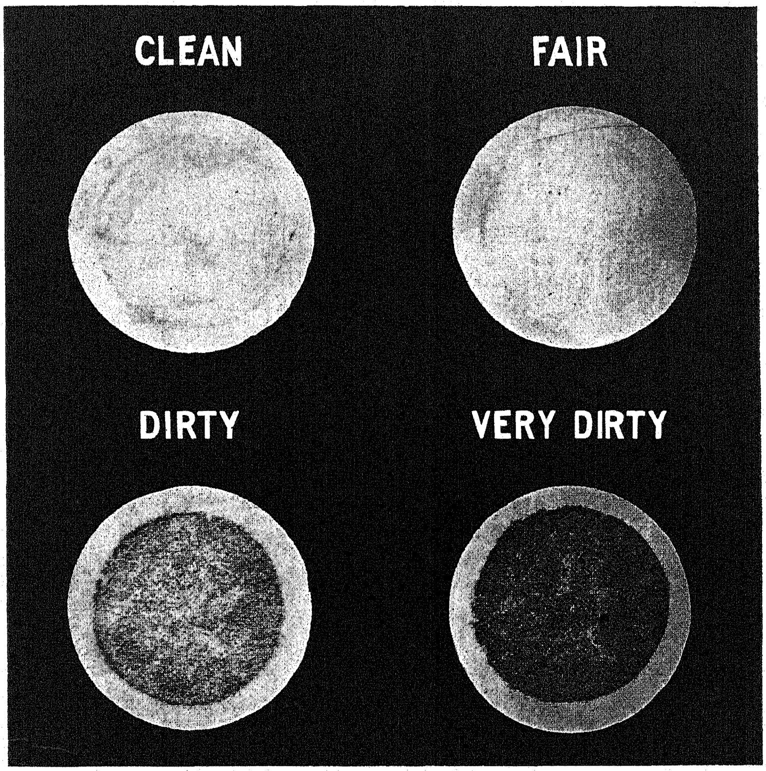
Where the test is repeated frequently at irregular intervals an improvement in cleanliness is likely to result, or a thicker farm strainer may be used, as no patron likes to have the dirtiest milk test all the time.

The sediment on the filter disc may consist mainly of fine grained black sand, where cows have access to a marsh, or may be yellow in color, indicating manure, or sometimes white and curdy due to garget. A slight yellowish tint may be due to the color of butter fat.

In very dirty sediment tests, particles of straw, chaff, silage, manure, hair, sand, etc., can often be seen.

Loose fitting packing in a sediment test may let dirt escape, and not show on the disc.

The milk sampling for this test may be done in two ways. If it is the purpose to compare one patron's test with another, a fair



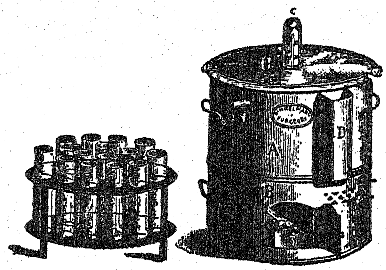
Sediment tests from different grades of milk.

way to take samples is to stir up each lot of milk in the weigh can, and then dip out the sample. If the purpose is to detect any dirt present in a can of milk, the last pint poured from the patron's can will usually contain most of the dirt, depending upon how little the milk is stirred at the time of sampling.

Dirty milk strained through cotton batting or flannel, may give a clean sediment test, and yet contain the dissolved dirt and the bacteria which cannot be strained out. Whether the sediment test is clean or not, it is most desirable to know some-

thing about the number and kind of bacteria in the milk, as shown by the following tests.

(16) The Fermentation Test. This has long been used in cheese factories to determine which patrons are bringing gassy milk. A sample is taken in a clean glass tube from each can of milk, placed in a warm box and kept warm at about 100 degrees F. for about 20 to 24 hours. The temperature should be closely controlled as below 100 degrees the gas producing bacteria may fail to work. Milk samples kept hanging on the wall at room temperatures are useless as a test. At 105-110, nearly all samples may show gas because the high temperature may check acid forming bacteria, and promote the growth of any gas bacteria that may be in the milk.



European fermentation test outfit heated with a small lamp.

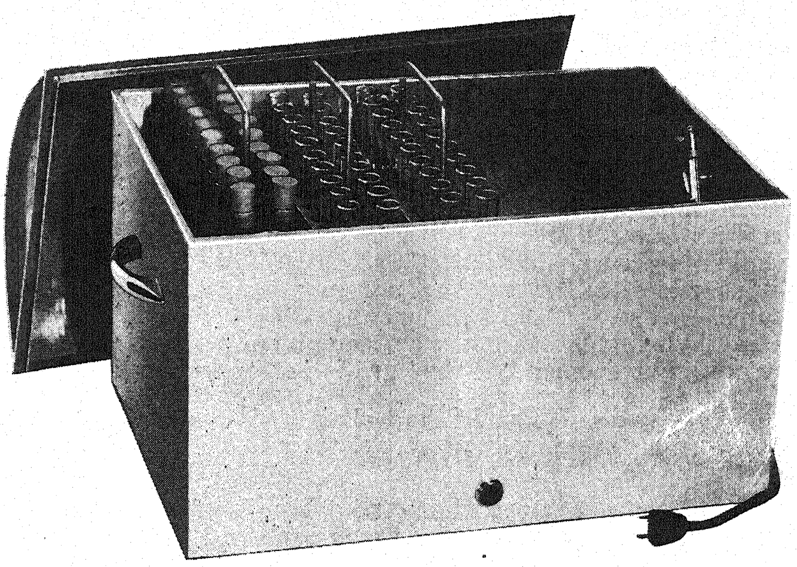
At the end of 20 hours, or just before the next day's milk is received, the tubes are inspected and classed as (1) No gas, or a trace, (2) Moderately gassy, (3) Very gassy.

Jelly glasses or test tubes may be used to hold the milk samples. A special milk test incubator may be purchased provided with metal racks and test tubes for holding samples from 80 or more cans of milk. If 10 c.c. samples are placed in each tube, they may be used for the methylene blue test also, as described below. A wooden box heated by an electric light bulb and controlled by a thermostatic switch is a very good form of incubator.

(17) Methylene Blue Test. As suggested by Professor E. G. Hastings, 10 c.c. of milk in a tube, is treated with 1 c.c. of a 1-20,000 solution of methylene blue, mixed well and placed in the incubator. The tube surface is roughened so that the patron number can be written easily with a black lead pencil. The more bacteria the milk contains, the quicker the blue color will turn white. Milk suitable for cheese should contain few bacteria and remain blue at 100 degrees for eight or six or at least five hours.

Outfits with electric heat for making the test in 30 or more milk samples, including sample dipper, tablets, tubes, container,

etc., are on the market. Many factories and commercial firms use four hours as the limit for acceptable milk.



Electric Incubator, with Thermo-Regulator.

(17A) Combined Methylene Blue and Fermentation Test. For this combined test, the tubes are inspected every half hour and the time recorded when each sample turns white, and all the samples are then left in the incubator at 100 degrees over night, to see if they then show gassy curds. Samples which remained blue for five hours or more, contain so few bacteria that they are not condemned even if they turn gassy in 22 hours, because the number of gas germs must be small in such samples, and the starter used in the vat will probably prevent them from causing a gassy cheese.

But milks which turn white in less than four hours (as in 5 to 30 minutes, or 1 to 3 hours) contain large numbers of bacteria, and are condemned on that account. If such samples also show gassy curds after 22 hours they must be considered most likely to cause gassy cheese. (17G)

Comparing several days records of tests, it is easy to see which patrons have the habit of bringing the worst milk, which may be the cause of defective cheese.

A weak point in the fermentation test used alone is that a very clean milk, containing only 8,000-10,000 bacteria per c.c. (not lactic) is likely to give a gassy curd, which would cause the

milk to be condemned by the cheesemaker depending on this test alone, whereas this milk may be among the best received at the factory.

Combined Rennet Test and Methylene Blue Test. To detect garget, the maker may apply a rennet coagulation test to milk samples collected in methylene blue tubes from herd cows, or separate quarters. A convenient method is to warm all the samples to 100 degrees, and add the methylene blue solution, as directed to all of the 10 c.c. samples, and then add to each tube 1 c.c. of diluted rennet extract, made by mixing well 1 c.c. of extract with about 200 c.c. or 7 ounces of cold water. Each tube is shaken well to mix extract and milk immediately, and the samples which fail to thicken promptly can be seen in a few minutes. (Jour. of Dairy Science (1936) 165; (1935) 741.) The methylene blue test can be completed as usual after the thickening has occurred, if the curd is not broken by shaking.

(17B) Wisconsin Curd Test. This is one of the older tests and consists of making small cheese from each patron's milk, in glass jars.

An outfit may be purchased for holding 6 or 12 milk samples. A wash tub and a set of two or three dozen pint fruit jars can be obtained at any country store, and will answer the purpose. Break the glass liners out of the covers.

The tub, jars, and covers are cleaned, and scalded thoroughly with boiling water or by running steam into the tubful of water containing the jars and lids. The empty jars are then covered and set in a clean place near the intake ready for use. A portion of each patron's milk is caught in a pint jar held over the weigh can, and the jar is marked with the patron's number. The jars are set in a tub of water at about 110 degrees for a short time, until the milk is raised to a temperature of 95-100 degrees, F. Six to ten drops of rennet extract are added to each jar, mixing it through the milk by shaking well with the lid on. After a few minutes standing quiet, the milk in each jar thickens, and the curd is then finely broken up by shaking well with the cover on, or by stirring with a well scalded knife. Shaking is preferred.

The jars should be kept at about 100 degrees, in order to favor the growth of bacteria in the milk and curd. An hour or more after breaking the curd, it will be seen that the curd has shrunk considerably, and much whey has separated. Several times during the afternoon the curd may be shaken again to break it up finer, and hasten the separation of whey.

Finally the whey may be poured from each jar by tipping it sideways, leaving the curd in the jar, and more whey may be poured off later. This leaves a little pat of curd or cheese in

Curds from milk of different quality as produced in the Wisconsin Curd Test.

Upper figure, curd from a good milk. Large, irregular, mechanical holes.

Middle figure, curd from tainted milk. Numerous small "pin holes" due to gas formed by harmful germs in the milk.

Lower figure, curd from a foul milk. When received this milk showed no abnormal symptoms, but the foul odor and spongy texture appeared in six to eight hours due to the presence of filth germs.

By means of this test, the factory operator can determine which patron brings the gassy milk causing defective cheese.

each jar, representing one patron's milk. By keeping these curds in an incubator at 100 degrees throughout the night, the best chance of a successful test is afforded. Next morning, each pat of curd is cut in two with a sharp knife, and examined for gas holes and bad odors.

This test consumes considerable time, and it has been largely replaced by the combined methylene blue and fermentation test, which requires less of the maker's time and tells more about the milk.

(17C) The Lactometer. Because milk contains solids-not-fat, casein, milk sugar, etc., it has a greater density than water. A can holding exactly 100 lbs. of water when full, will require about 103.2 lbs. of average whole milk to fill it. The density or specific gravity of water is 1.000, and in comparison with water the density of the milk is 1.032. A Quevenne lactometer put into this milk sinks to the 32 degree mark on the lactometer scale of figures, but put in water, it would sink deeper, to the zero mark. The lactometer test (L) of this milk is said to be 32 lactometer degrees.

The Lactometer in the Weigh Can. The simplest practical use which can be made of the lactometer is to float it in the weigh can full of any patron's milk, and read the figure on the lactometer scale at the surface of the milk. The purpose of this simple test is to find out if each patron's milk contains about the usual amount of solids-not-fat found in ordinary average normal milk, or whether one or more lots of milk may be low in solids because of gross adulteration, etc. With normal average milk, the Quevenne lactometer reading in the weigh can is closely in the neighborhood of 32 degrees, but with an adulterated milk containing only half of the normal amount of solids the reading would be about half of 32, or about 16 degrees. The weigh can test can be made rapidly on all patrons' milks, and if any are found reading as low as 25, 20 or 15 degrees, they are suspected of adulteration, and a quart jar sample may be taken out of the weigh can and labeled, to be examined more closely, later in the day, as follows:

The Solids Percentage Test. The object is to see how nearly the sample contains the legal percentage of solids-not-fat, 8.5% in Wisconsin, or to compare the factory sample with a barn sample. For this purpose, it is necessary, first to run a regular fat test on the milk sample. For illustration, suppose that the fat test is found to be 4%.

Second, the sample of milk in the jar should be brought to a temperature of about 60 degrees, that is to any temperature between 50 and 70 degrees. The milk sample is now mixed well by pouring it several times and the glass or tin lactometer cylinder is then filled with the milk, and set in a pan or pail to catch the overflow. The dry lactometer is lowered into the milk and allowed to float freely. The lactometer degree, called (L) is read on the stem exactly at the level of the milk surface, and the temperature of the milk is read from the thermometer scale at the top of the lactometer stem, and both are recorded.

If the milk temperature is not exactly 60 degrees, Fahrenheit, but somewhere between 50 and 70 degrees, a slight calculation is made to figure what the lactometer degrees would be, if the milk were exactly at 60 degrees.

Thus, to correct (L) for temperature, add .1 degree to (L) for each degree above 60 F. Or, if the milk is colder than 60 degrees, subtract .1 degree from (L) for each degree below 60 F.

For example, if the reading (L) was 32 on a sample of milk at 65 degrees F., the correction is made by adding .5 to 32, which gives 32.5 degrees (L), the correct lactometer reading for this milk at exactly 60 degrees. Or, if (L) was read 32, at 55 degrees F., the correction for temperature is made by subtracting .5 from 32, which gives 31.5 degrees, the correct lactometer reading for this milk sample at 60 degrees.

With this correct lactometer reading at 60 degrees, and with the fat test, 4%, on this sample of milk, the percentage of solids-not-fat in the milk sample is figured by use of the formula, as follows:

The per cent of solids-not-fat equals ¼ of (L), plus 1/5 of the fat per cent. If the correct value of (L) is 32.5, ¼ (L) equals 8.1. If the correct value of F is 4%, 1/5 F is .8, and the sum of 8.1 and .8 is 8.9% of solids-not-fat in the milk. These figures indicate that this sample of milk contains more than the required 8.5% of solids-not-fat, and therefore it is entirely lawful, and not classed as adulterated.

But, a sample of milk with 4% fat, and a corrected (L) of 16, would be seen to contain only 4.8% S. N. F., or much less than the legal requirement of 8.5%.

The value of this test for the cheesemaker lies in the fact that if a milk contains less than the normal percentage of solids-not-fat, the yield of cheese from that milk will be reduced, and the cheesemaker will have less cheese to sell than he expected to get.

At factories where milk is paid for according to the Babcock test, most patrons know that the removal of fat from milk by skimming reduces the pay check. Patrons know also that the

addition of water to milk not only increases the weight but also reduces the fat test, and does not increase the pay check at all, so that these two forms of adulteration are unprofitable, where payment is made by the fat test. But, if a patron ran a can full of night milk through the separator, or skimmed it by hand in the morning, and if he (2) took all of this skimmed milk to the barn for stock feed, and if he (3) poured the cream into a can full of morning milk, and stirred it up well, and if he (4) poured half of this mixture into an empty can and filled up both of the (half full) cans with water, and then delivered them at the cheese factory, the cheesemaker would fail to detect the adulteration unless he had a lactometer and used it at the intake.

As the weight of milk delivered in the two cans is the same as on other days, there is no cause for suspicion as to weight. If the milk looked watery, and the maker made a fat test on it, he would find the regular fat test for that patron, because all of the milk fat is in the cans. But if he put the lactometer into the weigh can of milk, and got a reading of only about 16 lactometer degrees, instead of the normal 32 degrees, he would know at once that solids-not-fat had been removed from the milk, that is, skim milk had been kept at home, and his cheese yield will be low on that account.

If 100 lbs. of skim milk is thus taken out, the loss of casein from the cheese vat would be about 2.5 lbs. But as each pound of casein carries with it into cheese about 1.5 to 1.75 lbs. of moisture, there is a loss of about 4.25 lbs. moisture, which added to 2.5 lbs. casein makes a total loss of about 7 lbs. cheese from the vat. If 300 lbs. of skim milk were thus removed, the cheese yield loss would be about 21 lbs.

On this account, every cheesemaker should have a lactometer, and use it at the intake on each weigh can full of milk, perhaps one day in the month, at irregular intervals, or whenever the cheese yield appears to be lower than it should be.

When factory milk gives abnormal tests, this may be due either (1) to low testing cows, or (2) to adulteration of milk after milking. The inspector has authority to take a barn sample of the milk for comparison with the factory sample, and also to take into court offenders who have adulterated their milk.

Adding cream to milk reduces the lactometer reading. Thus if milk contains 8.8% S. N. F., and 4% fat, testing 32 (L), any increase in the fat content will reduce the lactometer test, which may be calculated about as follows:

¼ L plus 1/5 fat % equals % S. N. F.

¼ L equals S. N. F. minus 1/5 fat %.

L equals 4 × S. N. F. minus 4/5 fat %.

If the fat % is 5%, and the S. N. F. 8.7%, then L becomes 30.8
If the fat % is 6%, and the S. N. F. 8.6%, then L becomes 29.6
If the fat % is 8%, and the S. N. F. 8.5%, then L becomes 27.6

Many other interesting cases may be studied in the laboratory.

Skimming fat from milk increases the lactometer test. Thus normal milk containing 8.8% solids-not-fat, and 4% fat will test 32 lactometer degrees. But if this same milk is run through the separator, freed from foam, and cooled to 60 F., it will now contain no fat, about (8.8/.96) 9.17% solids-not-fat, and the lactometer test will be about 36.7 degrees instead of 32.

Watering milk reduces the lactometer test. By adding the right amount of water to skim milk, the lactometer test can be reduced from 36.7 to 32, so that it will have the same test as whole milk. Since 32/36.7 equals .872, the mixing of 87.2 lbs. of this skim milk with 12.8 lbs. of water, will produce 100 lbs. of liquid testing 32 on the lactometer. When a fat test is made on the liquid, it contains none, and therefore it is not normal milk. The removal of fat was concealed from the lactometer by adding water.

Both the fat test and the lactometer should always be used in testing for adulteration of milk.

Most patrons know what the lactometer is for, and the presence and occasional use of the lactometer at the intake will discourage adulteration, besides detecting it when it occurs. Every cheese factory should have a lactometer in sight at the intake.

The reading on the 0-120 scale of the New York Board of Health lactometer, at 60 F., multiplied by .29 equals the Quevenne lactometer reading.

The Lactometer in Whey. In whey, at about 60 degrees F., the lactometer test ranges from 27 to 31. Some whey buyers offer 5 cents per 100 lbs. (at the factory) for whey testing 28 on the lactometer. The addition of 4% water reduces the lactometer test 1 degree, and reduces the whey value for making whey powder, since more water must be evaporated, and less powder is obtained per 100 lbs.

(17D) The Babcock Test. The Babcock test for fat in milk is too well known to need detailed description in this book, but some hints on its use are given in (77A), (113). (Nebraska Circ. 53.)

(17E) Walker Casein Test. This test, described in the Journal of Industrial and Engineering Chemistry, volume 6, page 131, February, 1914, is capable of being handled in any cheese

factory having an acidimeter (37), with a neutral 40% formalin solution and a 2 c.c. pipette.

Using a tenth normal solution of "lye" neutralizer in the acidimeter, 10 c.c. of milk is pipetted into a white cup, one c.c. of 1 per cent phenolphthalein neutralizer is added, and the alkali is run in with constant stirring, until a fairly deep pink color is produced. No account is kept of the volume of alkali used for this purpose. Two c.c. of neutral 40 per cent formalin solution are then added, which turns the milk sample white at once. The reading of the burette is now taken and alkali again added with stirring until the same pink color is produced. The burette is read again, and the difference between the two readings is the amount of alkali used in the second titration. One c.c. of N/10 alkali equals 1.47 per cent casein in the milk. One c.c. of N/9 alkali equals 1.63 per cent of casein in the milk. If a 9 c.c. pipette is used and N/10 alkali, 1 c.c. of the neutralizer equals 1.63 per cent casein in the milk. Although both milk casein and albumen are involved in the chemical reaction with the formalin, the use of the factors is said to give closely the percentage of casein. This test has been found useful also in standardizing milk for Swiss cheese making (205).

Modifications, for greater accuracy, have been recommended by F. H. McDowall, Pub. 68, Dairy Res. Inst., Palmerston N., New Zealand. 20 c.c. milk samples, 4 c.c. formalin, and 1 c.c. indicator are used. A color standard is made with 20 c.c. milk and 3 drops of a solution of 1/10 gram rosaniline acetate in 1 litre water. The acidity of the water white formalin solution is determined every week or two by (1) neutralizing 20 c.c. water, and then (2) adding 4 c.c. formalin and neutralizing again. The volume of neutralizer used in (2) is to be subtracted from the milk test.

Composite milk samples for this test should be preserved with color-free tablets of corrosive sublimate, 2 grains for 7 ounces milk.

(17F) Reazurin Test. With the same equipment as for the methylene blue test, the use of a .005% aqueous solution of reazurin (instead of methylene blue solution) causes color changes which progress from blue through lavender, pink and white. After one hour incubation at 98 F., a blue color indicates good milk, lavender fair quality, pink poor quality, and white very poor.

(17G) Payment by Methylene Blue Test. A recent report from C. A. Buck, Swiss Cheese Laboratories, Monroe, Wis., states that since 1938 several Wisconsin Swiss cheese factories (five in 1941) have been using such plans as the following. At least two

tests are made during each half-month. Milk should stay blue three hours. If any sample turns white in less than two hours, .1% fat is deducted from this patron's fat test for the two week period. If his second sample during the two week period turns white in less than two hours, the fat test is reduced by .2%.

At a second factory, the same plan is used, but with a three hour requirement instead of two.

By another plan in use, tests may be made on any day. If the milk turns white in two to three hours, the patron's milk weight is cut 20% for that day. If the time is between one and two hours, the cut is 40%. If the time is less than one hour, the cut is 50%. In every case, it has been observed that improvement in quality results, and the patrons demand that the plan be continued. (197A)

Oregon laws, 1937 and 1939 require that milk or cream obtained from the producer for any commercial purpose, except fluid milk or cream, shall be graded according to (a) the methylene blue test, (b) sediment content, or (c) acidity, etc. First grade milk stays blue 5½ hours. Also, any person receiving two or more grades of milk shall make a price differential, to the producer, of not less than one cent per lb. of butter fat, between grades. (Oregon Dept. of Agric. 1939 Circular 33, p. 3.) (Nat. B. & C. Jour. April, 1940, p. 46.)

(17H) Improvement of Milk Quality at the Factory.

Clarification. The modern clarifier removes dirt and part of the bacteria from milk, but not all. It has been used at some experiment stations (N. Y. 418, Ithaca) but without much improvement in American cheese quality. Its main use is to promote "eyes" in Swiss cheese (204) and for market milk.

Pasteurization, by tubular machine, or in a special vat, is now widely used in large factories (235) making American or cheddar cheese, or other kinds. In some factories, pasteurization is applied only to certain lots or vats of poor quality milk.

Pasteurization of Whey in the tank is the only practical way to kill yeast or gas bacteria lodged in the cracks between staves (220).

Sorting of Milk. By this plan night milk may be used in one vat for brick cheese, and the better quality of morning milk used in kettles for Swiss cheese.

Starters. Where milk and cheese contain only a few gas bacteria, the addition of ¼, ½, or 1% of starter may prevent the development of gas holes in the cheese, but too much starter is apt to cause sour flavor, short texture, and faded color.

CHAPTER IV.

Bacteria Affecting the Ripeness of Milk in the Cheese Vat

(18) Some Facts about Bacteria. Bacteria are alive. They are too small to be seen, without use of a microscope. About 30,000 bacteria make a row an inch long. Under favorable conditions, they grow rapidly to full size and then split in two, thus doubling their number in about half an hour. In this way, in about 15 hours, one of these bacteria can produce over 500,000,000 of the same kind. By cleanliness in milking we aim to keep them out of milk. By cooling their growth is checked.

In general, bacteria grow most rapidly at temperatures near 100 degrees, F., as in fresh, warm milk, but grow very slowly at 50 degrees, or below. By prompt cooling of milk to the temperature of well water, we aim to prevent their growth.

There are many different kinds of bacteria, just as there are many kinds of bugs, and weeds, growing wherever conditions enable them to spread. Under the microscope, the different kinds of bacteria can often be recognized by their shapes, round like a ball, rod shaped, oval, curved like a cork screw, some larger, some smaller, etc. They differ also in the kinds of foods they require, as milk sugar, glucose, proteins, salts, etc. Some require air, others do not.

One particular kind of bacteria causes typhoid fever, while other kinds produce dysentery, tuberculosis, or other diseases. Disease producing bacteria and many other kinds are easily killed by pasteurization at 145 degrees, while a few other kinds may require long continued, higher temperatures to kill them.

Just as different plants produce certain fruits, flowers, flavors, odors, or harmful substances (as poison ivy), so different kinds of bacteria during their growth produce different substances, flavors, odors, etc., which may affect the market value of milk, cheese, butter, etc.

As we learn more about them we understand better how to promote the growth of the helpful bacteria, and delay or prevent the growth of the troublesome kinds.

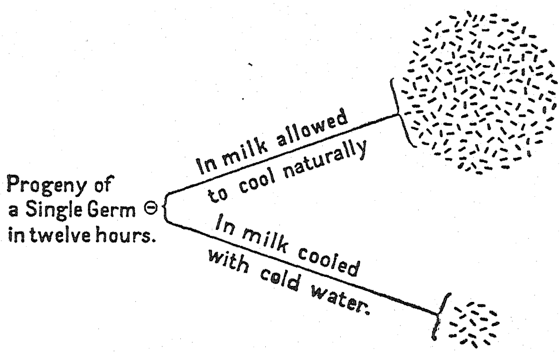
The bacteria in milk, differing in kind and number from day to day, are the main reason why the vat of milk "works" faster or slower, and requires constant watching by the cheesemaker. A few important kinds of bacteria will be described briefly here all of which may be found in any can of milk.

Air Requirements. Many kinds of bacteria require air and

are called **aerobic.** Others grow well in the absence of air, as inside of a cheese, or under the tin foil wrapping of a Limburger cheese, and these are called **anaerobic.** Some kinds grow well either in presence or absence of air, and are called **facultative.**

Lactic. Round like a ball. Grow fast at 86 degrees, F., and grow well at 72 to 100, F. Change milk sugar into lactic acid, up to about 1% acidity in milk. Growth delayed at 110, F. Killed easily by pasteurization at 125 degrees, F. Used in starters for American, cottage, brick, Limburger cheese, butter, etc.

Lactic bacteria are found abundantly in fresh corn, in silage, in milk, etc.



At temperature above 55 degrees, the growth of bacteria in milk is rapid. From Wis. Bul. 62.

Bulgaric. Long rod shaped. Grow best at 102-107, F. Change milk sugar into lactic acid up to 1.1-1.3% in ripe milk starter, or up to .6-.7% in ripe whey starter, or up to 2.0% or more in old cultures. About .1 to .2% is used for inoculations. Called "thermophilic" because it grows at high temperatures. Not killed at 125, F., in the Swiss kettle.

Thermophilic Coccus. Round like a ball. Grows best at 98-102, F. Produces lactic acid up to .6-.7% in milk starters, or to .35-.5% in whey, or up to 1.% in old cultures. About .05-.1% is used for inoculation. Not killed at 125, F. Present in Swiss cheese whey. It is believed to form acid in Swiss cheese curd at the high temperature of the kettle, and in the hot curd immediately after dipping. Later, as the curd cools, the Bulgaric bacteria take up the work of producing acid. J. Dairy Sci. (1935) 373, 502. (202B).

Coli. Short, rod shaped. Grow best at about 98, F. Very numerous in manure. Produce gas and manure flavors and odors in milk and cheese. Growth checked by acidity in milk and curd. Easily killed by pasteurization.

All of these and other kinds are likely to fall into any can of milk. Milk should be cooled promptly to 55, F., with well water at 52 or lower, to stop or delay further growth.

At the American cheese factory, starters are ripened at 72 to prevent Coli growth. Curd is made at 86, F., to promote Lactic growth, but retard Coli growth, and curd should show some slight acidity, to check Coli growth, before heating higher.

If milk contains too many Coli, gas and bad flavor are likely to occur in the cheese no matter how much Lactic starter is used.

Eye-forming Starter for Swiss Cheese. A culture of anaerobic, propionic-acid forming bacteria, first advocated in this country by the Dairy Division, U. S. Dept. of Agriculture, is now supplied to factories for addition to the kettle milk. It grows slowly and cannot easily be made in a factory. It should be kept cold, and used while fresh (within a week). When used, it greatly hastens the flavor as well as eye production. Eye former may be used at the rate of 8 c.c. per 100 pounds milk with rennet extract, or 5 c.c. or less with "lab" (61), during the fall and spring months, but may be omitted in hot summer, if cheese open readily, unless cold storage is immediately available to prevent cheese becoming too open.

The eye former is present in ordinary whey rennet, grown at about 86 degrees, but pure culture may be used in addition. This germ grows well at the temperature of the warm room.

Spore Forming Bacteria. While lactic and many other kinds of bacteria are easily killed at the usual pasteurization temperatures, 140 degrees for 30 minutes, or 165 degrees, flash, yet there are some kinds including some gas-formers, which are able to form spores within themselves, when heated, and the spores, once formed, can resist these temperatures and remain alive. Later when the hot milk is cooled, the spores can grow again into their ordinary form, and produce gas, etc., as usual, in the curd or cheese. This may be source of "late gas" in the cheese, when on the shelf a week or two.

To fully sterilize milk for starters, and thus kill all bacteria and spores, many Swiss cheese makers, in Wisconsin, heat to about 245 degrees, F., in a pressure sterilizer, at 12 lbs. steam pressure for 1½ hours. (See 28B)

Others heat milk at the temperature of exhaust steam, about 212 degrees, F., in a steam oven, or steam jacket, for four hours or more, throughout the morning. (28A)

Spore forming bacteria, if not killed in starter milk, are likely to develope gas in the starter test (33), or cause "late gas" in the cheese at the age of one or two weeks. (193C)

(18A) Effect of Salt on Bacterial Growth. Some makers have added a pail of salt to a vat of milk, intending to check gas. Experiments at the Dairy Research Institute, New Zealand showed that the addition of 1% salt always and 2% frequently, stimulated the growth of lactic bacteria, while 3% usually and 5% regularly inhibited growth, and 6% or more practically stopped growth. The addition of enough salt to delay bacterial growth will also delay rennet coagulation of the milk. (Jour. of Dairy Research (1933) p. 42.)

(19) The Acidity of Fresh Milk. Although perfectly fresh milk contains no lactic acid, yet it may show by the acidimeter about .12-.15 per cent acidity if low in solids (as from 3 to 3.5 per cent fat) or .16-.19 per cent acidity if high in solids (as from 4 to 6 per cent of fat), this apparent acidity being due to the casein, mineral salts, gasses, etc., normally present in fresh milk.

In an hour or two after milking, the acidity may decrease .01 or .02 per cent, due to escape of dissolved gasses.

During the storage of cooled milk over night, it may increase in acidity .02 per cent or more, depending on the number of lactic bacteria with which it was infected, and on the temperature at which it was kept.

(20) The Rate of Ripening in the Vat. From what has been said, it will be seen (1) that a vat full of fresh, sweet milk when received at the factory may show an acidity of .18-.20 per cent due to a high content of solids, if the milk is from Jersey, or Guernsey cows, or from Holstein cows near the close of the lactation period; but (2) on the other hand, an acidity of .18-.20 per cent in the low solids milk of fresh Holstein cows indicates that a considerable degree of bacterial ripening has taken place since this milk was drawn from the udder.

The contrast between the two becomes clearer as time passes, for the (2) sort of milk will ripen rapidly in the vat at 86 degrees F., while the (1) sort may remain warm in the vat for several hours without any increase of acidity.

It is important for the cheesemaker, having mixed night and morning milk, to (1) test the milk for ripeness as soon as possible after it is all in the vat, and (2) to judge whether the milk will ripen rapidly or slowly, at 86 degrees. For this purpose, repeated rennet tests or acidimeter tests are made at 10 or 20 minute intervals on the milk at 86 degrees. The maker considers also his experience with the milk at this factory on previous days, and any recent change in the weather or temperature at night, as well as Sundays, holidays, harvest, etc., which tend to cause milk to be neglected at the farm.

(21) "Fast" or "Slow" Ripening Milk. Milk which increases less than .05 per cent in acidity in 2½ hours at 86 degrees F., is "slow" ripening. "Normal" ripening milk increases .05-.10 per cent in acidity inside of two hours. Fast ripening or "overripe" milk may increase .10 per cent or more in 1-1½ hours, or less. The cheesemaker is always on the lookout for overripe milk, that he may hurry the work along as fast as necessary, to avoid getting sour cheese.

(22) Proportion of Starter. With slow ripening milk, the American cheesemaker adds sufficient starter to hurry the ripening, and avoid needless waste of time.

Where slow ripening milk is badly infected with harmful germs producing gas or tainted flavors, the judicious use of more starter than usual may secure the necessary ripeness quickly without affording the harmful germs time to grow in numbers. Acidity also delays their growth.

The proportion of starter most commonly used with American cheese is about one per cent of the weight of the milk. Less than one-half per cent is of little use in making this kind of cheese but may be useful with other kinds as brick, Limburger, Neufchatel, etc. With fresh milk, in cold weather, two per cent or sometimes more may be used, but care should be taken not to get a sour cheese. Overripe starter is likely to injure cheese flavor.

(22A) Changing Conditions. Sometimes in the Fall of the year, makers overlook the fact that the milk supply is shrinking, and fail to reduce the amount of starter accordingly, producing sour cheese through this neglect. The air temperature at night should be watched in Spring (8A).

(23) When and How to Add Starter to the Vat. To secure the most effect from the starter used, it should be fresh and active (25) and may be added to the vat with the first cans of milk received. By applying heat while taking in the milk, so as to keep the vat just below 86 degrees, the ripening begins at the earliest possible moment, thus saving time with very sweet milk. With riper milk, the starter is added and heat is applied only a short time before adding rennet.

If the milk is thought to be infected with gas or taint producing germs, whose growth should be prevented as far as possible, a little more starter than usual may be added early to secure the desired ripeness with the least loss of time. In such case, it is better not to heat the vat until just before adding rennet, as the acid forming bacteria will grow better than the gas forming bacteria at the vat temperature of 70-75 degrees.

With starter of a smooth, creamy consistency, vigorous stirring just before use will break up any lumps, but it is safer also to pour starter through a coarse metal strainer into the vat, to break up or remove lumps and distribute the lactic acid germs thoroughly throughout the milk. If possible, add starter to cold milk before heating up. Always stir the milk well while adding starter slowly. If the milk is warm, the sour starter may first be mixed with an equal amount of pure, cold water to avoid curdling the starter by the hot milk.

(24) Effect of Adding Starter. Immediately after adding starter, another acid test or rennet test may be made, and the milk may be found a very little higher in per cent of acid, or lower in time required to thicken with rennet, than before the starter was added, due to the lactic acid contained in the starter. The lactic germs in the starter will usually require an hour or more to begin producing acid after they are added to the vat. If repeated tests, made every few minutes after adding starter, show that the ripeness is steadily increasing, this is due to the lactic germs which were in the milk, before starter was added.

(25) Qualities of a Good Starter. A first class lactic starter for creamery use usually will be good also for cheesemaking, although a poor starter is perhaps more likely to injure the quality of cheese than of butter.

A good lactic starter should have a pleasant, mild, acid flavor and odor. The texture should be free from gas holes, and should not be wheyed off, but smooth and creamy in order that when stirred into the vat, the starter may dissolve and the lactic germs may be easily distributed through the milk and not retained in lumps of curd. A starter contains the largest number of living, active lactic germs when its acidity is about .6-.7 per cent, or when it has just recently thickened at 72, F. It is then in good condition either for adding to the cheese vat, or for transfer to another lot of milk for starter making. With proper handling, a good starter can be kept in daily use without deterioration for a long time, sometimes for months or years. For this purpose, the best rule is to transfer it every day into well pasteurized selected milk (33).

For Swiss cheese, a bulgaric starter is used because the bulgaric germs are not killed at the high temperature of the Swiss cheese kettle.

(25A) The Growth of A Starter. Growth is more rapid in milk than in whey because the concentration of food is higher in milk. After starter milk, at incubator temperature, is inoculated, from an old culture, there is a delay or "lag" of two to four hours, before the "old" bacteria, in their new food supply,

become rejuvenated enough to start producing acid, and increasing in number.

By splitting in two, every 15 or 20 minutes, the number of bacteria is doubled repeatedly during a "period of rapid growth," which may extend over 14 to 16 hours, until the maximum rate of increase is approached. During the "period of rapid growth," at 100 degrees, F., the bacteria are in the best condition for inoculation into the kettle, because they will grow without "lag," and have greater ability to live through the 125 degree kettle heat. Read "Fundamentals of Dairy Science," Rogers, pp. 302-312.

During the next six to 18 hours, the number of bacteria present remains at a maximum, the rapid growth rate being offset by the increasing death rate, due to increasing acidity, etc. As acidity approaches its maximum, the bacteria decrease rapidly in number, and the culture becomes "old."

CHAPTER V.

Making a Lactic Starter for Cheese

For Bulgaric or Swiss cheese starters, see chapter XXVI.

(26) Materials for Making Starter. To prepare 1 per cent of lactic starter for use with 5,000 pounds of milk, obtain (1) 55-60 pounds of the best clean, fresh milk, and (2) a pint of first class sour milk, or starter, or a commercial pure culture of lactic acid germs.

(27) Select Milk for Starter Making. To get suitable milk for starter making, it is best to select the fresh, morning milk, or best milk from the best patron, and pour this directly into cans used for starter making. Milk taken from the cheese vat is not so good, because some gas, spore, (18) or taint producing germs may have been present in the milk from one farm or another.

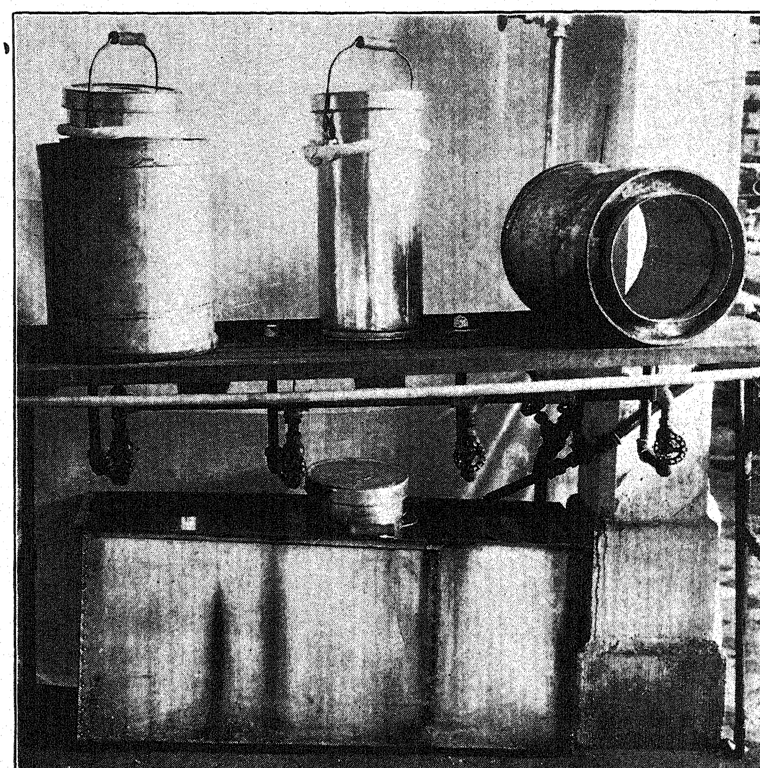
Mixed skim milk, or whey from today's cheese is not so good to make tomorrow's starter with, because it may carry over harmful germs from one day to the next. Buttermilk used as starter has often resulted in bad flavored cheese.

(28) Pasteurize the Starter Milk. The cans of starter milk are set at once in a steam jacket or oven, or in a small tank or half barrel of hot water, heated with steam nearly to boiling, so that the milk soon reaches 180 degrees or higher. Keep a cover on milk can while heating. A metal cream stirrer may be kept inside, reaching from the bottom of the can to the top just under the cover. The starter milk is kept at 180 degrees at least, for not less than one-half hour, and better at a higher temperature for a longer time. A good plan is to heat up the milk as soon as received, and keep it hot 4 or 5 hours at 210 degrees.

The covered cans are then set in cold water to cool down to about 72 degrees. If the water in the tub is then at about 72 degrees, the milk will remain at the temperature for several hours, after inoculation for souring.

(28A) Steam-Oven or Jacket. In pasteurizing milk for starter, it is desirable to prevent certain harmful bacteria from forming spores by heating the milk as quickly as possible to a high temperature. The can of milk should therefore be set into hot water (rather than cold), or into a steam jacket, or oven, or a sterilizer. A wash boiler with cover and containing a little water, heated on a stove to boiling will answer the purpose in an emergency.

For a steam oven a galvanized iron box with a door large enough to admit a milk can may be made by any tinner. A



The first steam table and jacket, with cooling tank beneath, at the Wisconsin Dairy School.

steam jet inside is controlled by a valve outside, and the door is not steam tight. Other utensils can be steamed in the box at the same time.

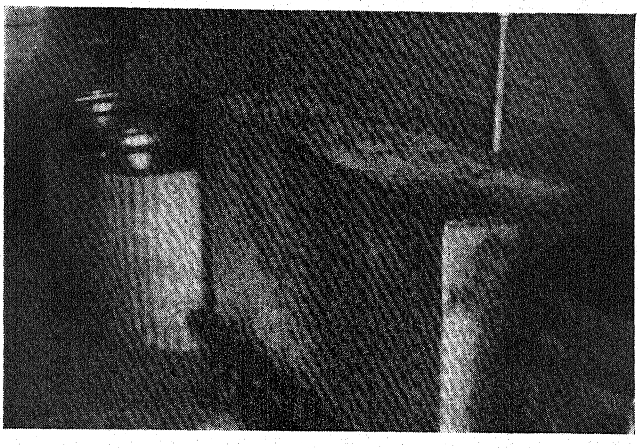
A steam table can be made in any factory. The steam table is a plank 16 inches square or larger with a hole bored about two inches from one side, through which a steam pipe extends. A hand valve is below the table. Any pail, large can, or tub can be inverted over the steam jet, as a jacket, to contain any articles which it is desired to heat.

With table legs about a foot long, it is easy to sweep under the table, and to lift the starter can into place.

The can of starter milk, with its cover in place, and with a metal stirrer inside, is set on the steam table. The jacket can is set over it, with the steam jet just inside of the jacket.

When heating starter milk in a single ten gallon can, the most convenient steam jacket is a 15 or 20 gallon can, new or old, which will fit down loosely over the can of milk on the steam table.

In a larger factory, requiring several cans of starter daily, the ten gallon cans of milk may be set in a row on the steam table, and covered with a galvanized iron jacket, made by the tinner, as shown below. One steam jet is sufficient. If the jacket

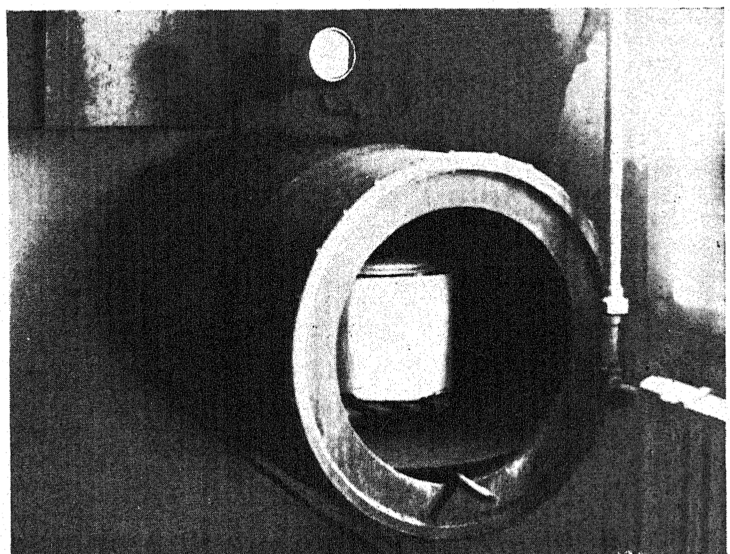


Steam jacket for four cans of starter.

does not fit the table top closely, a strip of twisted cloth may be drawn up around the jacket, on the table top. Steam is turned on, so that only a little escapes into the air. This arrangement heats the milk quickly to 200-210 degrees. Slight browning of the milk which takes place, in four to five hours, is due to the effect of heat on the milk sugar. It may color the cheese very slightly, but does not injure the starter or the cheese flavor. This steam jacket is preferred by many makers who have used it, rather than a hot water tank for starter heating, because it takes less steam, and it heats the milk quicker and hotter. An empty bottle or two can be steamed inside the jacket at the same time, for making mother starter. The entire equipment is quickly made at home, at little or no cost.

(28B) Steam Pressure Sterilizer. By heating starter milk in a steel drum with 12 pounds steam pressure about 245, F., for 1½ hours, all bacteria and spores are killed. This quick method has been used at some Swiss factories, at moderate cost.

(29) Setting the Starter. During the noon hour or later, the heated starter milk is cooled to 72 degrees. In order to have



Horizontal steam pressure sterilizer.

the lactic starter thick and ready for use when needed next morning (but not overripe), add just enough of the culture, perhaps 2 per cent, to the cooled milk, and add it at the right time during the afternoon so that the milk will thicken only a short time before it is to be used, next day. Do not add so much culture that the milk will thicken the same afternoon. Stir in the culture thoroughly, and cover, leaving the stirrer inside.

(30) Temperature of Ripening. A good temperature for setting and ripening lactic starter is about 72 degrees, F., because, (1) at 90-100 degrees, gas forming or putrefactive germs if present will grow well, but at 72 degrees they will grow much less, while the lactic germs will grow abundantly at this temperature; (2) starter thickened at about 72 degrees is smooth and creamy, but is likely to be lumpy and tough if at a higher temperature; (3) a starter is more likely to take on a sharp, sour flavor and become overripe at 100 degrees than at the lower temperature (25). If the starter cools a little below 72 degrees during the night, no harm is done. In warm weather, the partly soured starter may be set in cooler water late in the evening, or may be carried to a cool room. Keep it covered.

(31) Making Starter Every Other Day. Where cheese is made every other day, (1) the best way is to steam sterilize a can of starter milk with cover on and also a quart jar of milk, when making cheese. The jar of milk is cooled to 72, F., inocu-

lated and ripened over night. The can of sterilized milk is kept covered over the first night, and the next day it is cooled to 72, inoculated and ripened over night for use in the cheese vat the following day. If the can of milk thickens during the first night, it was not completely sterilized, or was infected (accidentally inoculated) too soon.

(2) Another way is to set the starter in the can late on the first day, and at night or the next morning place the can in the refrigerator to keep it cool until the following day when it is to be used. A good starter may often be kept good by this method, but if not very good to begin with the starter is likely to deteriorate in a few days so as to be unfit for use. It is safer to make a transfer daily.

(32) Making Starter Daily.

(1) Having two cans, the starter for today is contained in the first, but the other is empty and is cleaned and steamed out in time to receive the new starter milk when delivered, and is then pasteurized. When adding starter to the cheese vat, a small amount is left in the can with the cover on, for transfer to the other can later in the day.

(2) If only one starter can is used, steam a glass jar in the jacket during the morning, and in the afternoon, after adding the culture to the pasteurized milk, and mixing well, fill the jar from the can, cover and leave in the factory at about 72 degrees. This jar of mother starter is left undisturbed until the next afternoon, when it is transferred to the new lot of pasteurized milk in the can. Most makers prefer this plan.

(33) Testing the Quality of a Starter. It is a good plan, at intervals, to put up an extra jar of starter in this way, and to let it stand unopened and unshaken for several days, or a week during which it is examined to see if it has developed gas bubbles, or has wheyed off. If so, get a new one. The acidity of a starter, at the time when added to milk in the vat, should be .65-.70%, since the bacteria are then most numerous and active.

(34) Commercial Culture for Starter Making. In addition to a supply of good starter milk (section 27) a good culture of lactic germs must also be provided. This may be a portion of yesterday's starter, or it may be obtained either (1) from a neighboring cheese factory, or (2) by purchase from a dealer in factory supplies, or (3) as a "natural" starter.

Dealers supply commercial cultures in small bottles as "liquid" or as a "dry" powder. The liquid culture should have stood long enough to curdle in the bottle, but should be used for starter making while fresh as shown by the date on the bottle. A dry culture on the other hand will keep in good condition in

the bottle for a somewhat longer time, but may be slower in growing when first used, as the drying of the culture may kill a part of the germs present. Full directions are printed on the bottle, for growing these cultures for one to three days in glass jars before using them in a large can of starter.

(35) Natural Starter. To obtain a "natural" lactic starter, scald out several pint fruit jars with lids, carry these to a nearby farm selected for cleanliness. With clean hands and other precautions to exclude dirt (sections 6, 7) draw some milk from a clean cow. Throw away the first two or three streams of milk from the teat, and then milk directly into one of the jars. Repeat this with several jars and different cows. Take all the jars to the factory. Keep them covered at about 70-80 degrees until the milk thickens, which may require 12 to 48 hours. Reject any curds which are gassy or wheyed off, and select the best flavored of the remaining curds, if satisfactory, to be transferred to some pasteurized milk for starter making. Sometimes all of the samples thus taken at a barn may turn out unsatisfactory, and another set may be taken from another source. The commercial culture is commonly preferred as quicker, and surer to be satisfactory.

CHAPTER VI.

Tests for Ripeness of Milk, Curd, Whey, Starter, Etc.

(36) Odor and Taste. By the odor or taste of milk at the intake, or of milk or whey in the vat, or of starter, an experienced factoryman often can judge the condition of milk, whey, etc., at intervals during the working, but the acidimeter gives more accurate results, as to acidity. (Wis. Res. Bul. 127.)

(37) The Acidimeter or "Manns' Acid Test." (a) This test is very generally used in Canadian cheese factories, and has been used with satisfaction by a large number of leading cheesemakers in the United States.

The test is made in a variety of modified forms. The most practical method is probably the following:

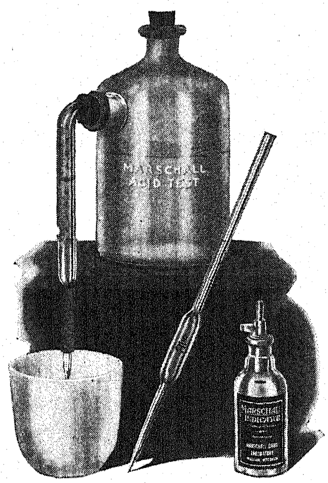
(b) A 9 c.c. or a 17.6 c.c. or an 8.8 c.c. pipette is filled to the mark with the milk, whey, or starter to be tested, and is then emptied into a white porcelain cup, preferably wide and flat bottomed rather than narrow and deep. (c) Two drops of indicator solution are then added to the cup. The indicator solution contains 10 grams of phenolphthalein powder dissolved in a quart of denatured alcohol, and may be neutralized. Sometimes the more expensive 95% grain alcohol is used for the purpose, dissolving the powder completely in one pint of the alcohol, and then adding slowly about two-thirds of a pint of distilled water or condensed steam, or rain water, but not adding enough water to make the liquid turn milky white.

(c) From a burette holding 10 cubic centimeters, or more, and graduated in one-tenth c.c. divisions, a solution of "neutralizer" or "tenth-normal alkali" is run in a rapid series of drops into the milk in the cup. As the first drops of "neutralizer" enter the milk a red color is produced, but this quickly disappears on shaking the cup held in the right hand, or stirring the milk with a rod. This shaking and the addition of neutralizer rapidly by drops go on until the last drop added produces a faint pink color which spreads through the milk and does not disappear on thorough mixing although it fades later. A convenient color standard in a glass tube is on the market.

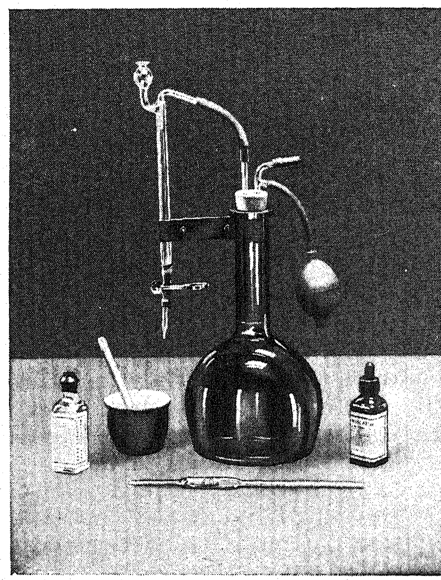
(d) The quantity of the neutralizer solution used is read from the burette, and (if 17.6 c.c. milk was used) is divided by 20 to obtain the percentage of acidity in the milk. Thus fresh milk may require 2.8 c.c., which divided by 20, gives .14/100%

as the acidity. Milk for American cheesemaking should not take over 4.0 c.c., equal to .20% acidity. Sour whey or curd drippings or overripe starter may use up to 16 to 20 c.c. neutralizer, showing .8 to 1.0% acidity.

(e) Sometimes, and especially with sour material, it is better to use a 9 or 8.8 c.c. pipette instead of 17.6 c.c., thus saving half



Marschall Acid Test.



Kimble Acid Test.

of the neutralizer; and the volume of neutralizer used is divided by 10 instead of 20 to get the percentage acidity.

In England, N/9 neutralizer is used, and 10 c.c. milk samples.

The speed and convenience of the acid test is much greater if the automatic Kimble, Marschall or similar form is used, in the burette and neutralizer bottle are connected by a glass tube, through which the neutralizer runs.

(38) Neutralizer. The neutralizer is commonly a solution of lye of exactly the right strength, and can be bought from a dealer ready made at $1 per gallon or in concentrated form in a small bottle to be dissolved in one gallon of soft water. The solution should be kept in a rubber stoppered bottle or jug to protect it from the air.

A package of powder consisting of soda ash may also be purchased, to be dissolved in a half gallon of soft water.

(39) Alcohol Test. When 2 c.c. of 68% (by volume) alcohol are added to 2 c.c. of milk in a test tube, and gently shaken, the appearance of curdling may be taken to indicate that the milk has ripened considerably or is abnormal in other respects, so that it should be returned to the farm. This test is used at some condensaries, and is not always considered reliable. (H. H. Sommer, The Milk Dealer, Feb. 1929, page 63.)

(40) The pH Test, or Hydrogen Ion Concentration Test. The simple and inexpensive acidimeter, using a "neutralizer" and using phenolphthalein "indicator", will no doubt continue to be used widely by cheese makers, for measuring the acidity of milk, whey and starter. Buttermakers use it to determine the acidity of cream, and the quantity of neutralizer to be added to sour cream, for butter making purposes. The same test is used in other industries.

The pH test can be applied to milk, whey, and starter, and to curd or cheese at any stage of manufacture or curing; also to liquids and solids in many other industries. Examples of results with cheese are shown at (189A), (213A), (225).

The results of pH tests are stated on a scale of numbers, from 1 to 13. Strong acidity as of a tenth-normal hydrochloric acid solution is represented by the figure 1 on this scale. The weak acidity (or strong alkalinity) of tenth normal sodium hydroxide solution is represented by the figure 13; and the true neutral point, as of pure water, is at the figure 7. (See Nat. Butter and Cheese Journal, June, 1939, p. 18). Sweet milk tests 6.8 to 7.1, and sour milk may test 4.7 to 5.6. White bread tests 5.0 to 5.5. A strong washing powder solution may test about 9 or 10; canned tomatoes somewhat below 5, and dilute vinegar about 3 on this scale.

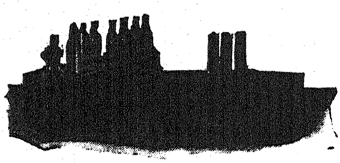
In many industries, as in commercial laundries, in bread and cake baking, in the bleaching of flour, in brick making, in selecting the materials for a batch of process cheese, or salad dressing, etc., the pH test is used as a guide in securing the desired acidity or alkalinity of materials in the mixture, to obtain the best results, as in washing milk cans, or in laundry work, or to secure the desired consistency of bread, or of process cheese, or to regulate bacterial growth and eye formation in the making of Swiss cheese, etc., or wherever acidity must be closely controlled.

Two methods may be used in measuring the pH number of a sample of milk, curd, bread dough, soap, etc. One method uses a series of indicators; the other requires the use of an electrometer.

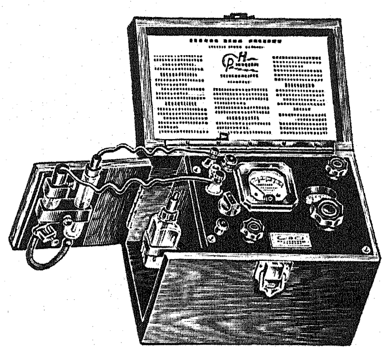
For the "indicator" method, various chemical supply houses furnish a set of selected indicators (dye stuffs) each of which has the property of changing its color over a specific pH range. For example, phenolphthalein changes from colorless to faint pink at pH 8.3, and changes further up to 10.0. From 8.3 to 10.0 is the pH range for this indicator. From the large number of available dye stuffs, a series can be selected to cover any part of the pH scale, or all of it from 1 to 13, as in the table.

Indicator	pH range	Indicator	pH range
Methyl red	0.0—2.0	Bromo-thymol blue	6.0— 7.6
Ethyl orange	2.0—4.0	Cresol red	7.2— 8.8
Methyl orange	2.9—4.0	Phenolphthalein	8.3—10.0
Congo red	3.0—5.0	Alizarin yellow, G	10.1—12.1
Methyl red (para)	4.4—6.0	Sodium indigosulphonate	12.0—14.0

By means of such indicators, and a set of color standards, also purchased, the operator can determine with a fair degree of accuracy the pH number of any material, often by simply dropping the indicator on the solid material to be tested, or by mixing liquids in a test tube, and comparing the color produced, with the standard colors. These indicators, however, can not be used on materials with a high natural color. A yellow cake, for example, may have enough color to make the results of the indicator test doubtful.



pH Test Indicator Outfit.



pH Test Electrometer Outfit.

The "electrometer" method for the pH test is quicker, more accurate, and can be applied to liquid or solid materials of any color. The pH number is read directly from a dial. The complete outfit in a case costs sixty-five dollars, or more. It is used in many laboratories and manufacturing plants.

Further information about the "pee-aitch" test can be obtained by writing to firms listed in the advertising pages.

(41) Rennet Tests Measure Ripeness of Milk. Sour or partly ripe milk thickens more quickly with rennet than does sweet

milk. By mixing a measured quantity of milk at 86 degrees, with a measured amount of rennet extract, and noting on the watch the exact number of minutes and seconds required for the first visible thickening, the ripeness of the milk can be judged. The Marschall test, Monrad test, and Harris test have been used by cheesemakers for this purpose.

In making rennet tests it is necessary to work at the specified temperature. (44) Every factory should have one accurate thermometer to compare with those used daily.

(42) Milk Thickens Most Rapidly at About 106 Degrees. The relative time required to thicken milk with rennet at different temperatures, all other conditions being the same, is shown in the table.

68F	77F	86F	95F	100F	102F	104F	105.8F	108F	113F	117F	118	120	122
555	225	141	116	107	104	102	100	102	112	128	144	167	200

For cheesemaking purposes, milk is always thickened between 68 F. and 118 F., and in most cases between 86 and 100 F.

(43) Dissolved Substances in Milk Affect Coagulation. The addition of almost any soluble substance to milk delays or hastens its coagulation with rennet.

The addition of water to milk at the farm makes it necessary to use more extract at the factory.

The addition of formaldehyde to milk at first delays coagulation and later entirely prevents it.

Higher acidity produced either by ripening or by addition of an acid causes milk to coagulate more quickly with rennet. This fact is the basis of the use of rennet tests.

The addition of .1 or .2% soluble lime salts as calcium chloride to milk hastens rennet coagulation, while common salt or alkalis delay it. Some makers add salt to milk supposing it possible thereby to avoid gassy cheese, but this delays curdling. 1 or 2% salt may promote bacterial growth, but 3% or more usually delays it. Jour. Bact. 11, 1 (1926).

Too high pasteurization of milk, or boiling followed by cooling, greatly delays coagulation, but the addition of an acid or a soluble lime salt restores the rennet action.

Milk from high testing cows, as Guernseys or Jerseys, often thickens quicker than low testing milk.

Feeding cow feeds which are low or high in lime content does not immediately affect the lime content of their milk, as a cow will put the proper amount of lime in her milk even if necessary to take the lime from her own body. Milk containing colostrum, and often the milk of sick or underfed cows will not curdle normally with rennet (50B).

Milk kept in rusty cans or in cans which have tin worn off and bare iron exposed, will dissolve a little of the iron or rust, and as a result will not thicken so quickly with rennet. (Wis. Ann. Rept. 1907, p. 134.)

Sometimes in a factory, milk may thicken slowly because a thermometer reads too high, and the milk is too cold.

Any condition which weakens the strength of rennet will delay milk coagulation (55).

(44) Marschall Rennet Test. The Marschall test cup is filled above the zero mark with milk from the vat at 86 degrees and is set on the corner of the vat. The milk runs slowly through the small hole in the bottom of the cup until thickening occurs. A scale of figures on the inside of the cup shows, approximately in minutes how long the milk has been running out. The new scale of figures in the improved Marschall rennet test runs from zero to 5, instead of zero to 10, but the outlet is larger, and the final reading is the same in both forms of the test.

A small bottle is filled to the mark with about 20 c.c. of cold

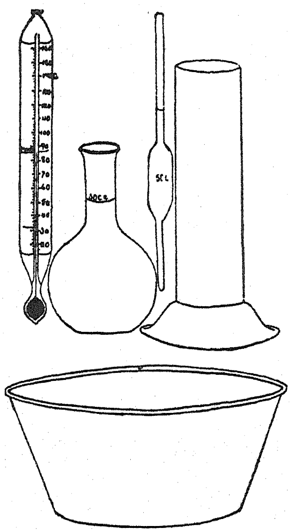
Marschall Rennet Test. The most convenient and widely used form of rennet test. The recently improved form is shown.

water, and 1 c.c. of rennet extract is added, rinsing the pipette by drawing up the water once or twice.

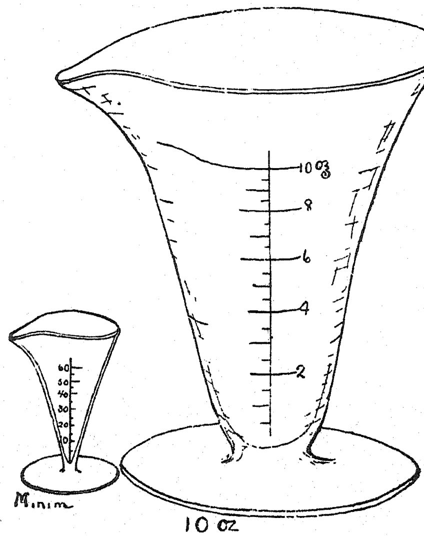
When the milk in the test cup has run down until the zero mark at the top of the scale shows at the top of the milk, the diluted extract is quickly added and stirred in thoroughly for about half a minute with a thermometer or spoon. The thermometer may be left in the milk and read after the test to see whether the temperature has fallen.

As soon as the milk thickens in the cup, it closes the hole and stops running out. The reading on the scale at the top of the milk may be 1½ or 2 for over-ripe milk, 2½ to 3½ for moderately ripe milk, or 4 to 5 or more for very sweet milk. Always clean the cup and the hole before making the test. With very sweet milk at a Swiss cheese factory 2 c.c. of rennet extract may be used instead of 1 c.c. if necessary.

(45) The Monrad Rennet Test. For this test, 5 c.c. of rennet extract are measured with a pipette into a 50 c.c. flask, containing some clean cool water. The pipette is rinsed by drawing up the water, and the flask is then filled to the 50 c.c. mark on



The Monrad Rennet Test.



The Harris Rennet Test.

the neck with water. The contents are mixed thoroughly by shaking.

One hundred sixty c.c. of milk from the vat, at 86 degrees, are measured in a tall, tin cylinder, and poured into a cup set into a small pan containing water at about 88 degrees to keep the milk at 86 degrees. While stirring the milk with a thermometer, quickly add a 5 c.c. pipette full of the diluted rennet to the milk in the pan, and note by the watch the exact second when the addition was made. Stir in the rennet quickly for half a minute or less, and at the same time add a few particles of fine charcoal dust. This dust shows when the milk thickens, by suddenly stopping its movement around the pan, appearing to move backward a trifle as it stops, when the time is again read by the watch.

To deliver the diluted rennet quickly, the pipette should have a wide tip, or the liquid should be run out of its wide upper end turned downward for this purpose.

(46) The Harris Rennet Test. In this test, 8 (or in some cases 10) ounces of milk at 86 degrees are taken up from the vat in a conical glass graduate, and ½ dram of extract mixed with ½ dram of water is added at a time noted by the watch. The extract is stirred in well with a thermometer for 5 or 10 seconds, and the time is again noted on the watch when the milk first thickens. ⅛ ounce equals 1 dram, or 30 minims.

(47) To Obtain Accurate Rennet Tests. Important precautions in making rennet tests: (1) To have the milk always at the same temperature, by the same thermometer, (2) to use the same lot of extract in a series of tests, as different extracts may vary in strength, (3) to use the same measuring vessels, as these may vary slightly in size, (4) to fill pipettes, etc., so that the bottom of the curved fluid surface is exactly on the mark, (5) to run duplicate tests.

Neglect of these precautions may cause irregular results. Tests made at different factories, even on the same milk, may vary somewhat, because the different sets of equipment may vary slightly in size. But at any one factory, tests made with the precautions listed above, will show clearly the ripeness of the milk, and its variations from day to day due to differences in the way it has been handled by patrons, etc.

(48) Experiments Using the Rennet Tests. For the class a can of milk or skim milk should be provided, fresh and cooled to the temperature of well water or below, in order to avoid ripening during the hour of work, so that comparable results can be obtained. The students pass along from one table to another, on which the different test outfits are arranged. Be very careful not to pour any milk back into the large supply can, and thus avoid accidents, such as getting a little rennet into it.

(a) Test duplicate portions of the same lot of milk with the acidimeter, the Marschall test, the Monrad test, and Harris test. While performing this experiment with the Marschall test, observe the time in minutes and seconds on the watch, from the addition of rennet until the milk stream stops running. Does the scale of figures inside the Marschall test give the time in minutes or not? Are all Marschall tests alike?

After completing each test as directed above, find how much milk (or water) the measures used will hold, by means of a 100 c.c. or a 500 c.c. measuring cylinder. Which test uses the largest proportion of milk to rennet? Does the time required

for coagulation depend upon the proportion of rennet added to the milk? Every student should complete this experiment in good order, and write it up.

The remaining experiments described below may be performed by advanced students, so far as time permits, or may be postponed, or omitted entirely, as directed by the instructor.

(b) Using the Monrad test, (as it requires the least milk) make several tests on milk from the can, at different temperatures, 65, 75, 85, 95, 105, 115, 125 degrees F., to determine at what temperature coagulation occurs most quickly.

(c) Heat some milk in a flask to about 180 degrees or higher over a flame or by placing in boiling water, and then cool in cold water to 86 degrees. Make a Monrad test. Does this pasteurization interfere with rennet coagulation?

(d) To 100 c.c. portions of milk from the can, measured out for the Monrad test, add different amounts of calcium chloride, or barium chloride, ¼, ½, 1, 2, 5, 10 grams, dissolve, and then complete the tests as usual. Try also different amounts of common salt, potassium chloride, borax, or sodium carbonate in similar tests. What substances aid or delay rennet action?

(e) Add 5% of starter to a pail of milk, mix well and heat to 100 F., to ripen. Cool immediately a small portion of the milk to 86 degrees F., for a Monrad test, and test other portions at half hour intervals, at the same time making acidimeter tests. Which test detects small differences of acidity with greater certainty? How soon does ripening start?

(f) Make several rennet tests, using different lots of rennet extract, fresh, or old, from different makers.

(g) Compare rennet extract and a 6% pepsin solution by making a Monrad test or Marschall test with each, using sweet milk for both, and afterward repeat the trials using milk at about .20-.22% acidity for each. Which is better for sweet milk, rennet or pepsin?

(h) Dilute some extract with water for the Monrad test, and let it stand at room temperature for an hour, a day, or a week. Then dilute a second flask of the same extract, and immediately make rennet tests with both. Does diluted rennet extract lose strength on standing? Compare the odor.

(i) To 10 c.c. of rennet extract, add a pinch of sal soda, or lye, or any washing powder, then use the mixture for a rennet test. Does the alkali injure rennet?

(j) Damage by heat. Place a few ounces of rennet extract from the main supply in each of two stoppered bottles. Place one in a warm place, as in the make room or boiler room, at 90-100 degrees for a week. Leave the other in the cellar, or the ice box. Compare as to strength.

(k) Damage by light. Set up two small stoppered bottles, of undiluted rennet extract, place both together on a shelf by the window, but cover one with a glass beaker, the other with an opaque cover. Compare their strength after a week or a month.

(49) Advantages of Rennet Tests, and Acidimeter Tests. The acidimeter can be applied to milk at the intake, and also to whey or drippings from the curd at every stage of the cheesemaking process. The test is made quickly, and the result is not affected by temperature. Makers who have become thoroughly familiar with it recommend it highly, in place of rennet tests and hot iron tests.

For the rennet tests the milk must be at 86 degrees F., but they do not require a special "neutralizer" or "indicator" solution, but are made with the same rennet extract which the maker buys in a jug for cheesemaking.

The Marschall test cup makes the use of a watch unnecessary, and the maker can read the test at any time. The Monrad and Harris tests require a watch, with second hand, but can be made with simple and inexpensive vessels.

The rennet test, with the time measured in seconds, will detect small changes in the ripeness of milk more readily than the acidimeter, but the acidimeter does well enough.

(50) Comparison of Rennet Test and Acidimeter Results. In the Marschall test, about 800 c.c. of milk and 1 c.c. of rennet are used, so that the milk volume is 800 times larger than the rennet. In the Monrad test, the volume of milk is 320 times larger and in the Harris test 128 times larger. (B. A. I. Cir. 210.)

The smaller the volume of milk used to 1 of rennet, the quicker the milk will thicken. On this basis, a comparison of the different tests can be made, with a fair degree of accuracy, as shown in the table.

Name	Proportions	Time for		
		Ripe	Medium	Sweet Milk
Marschall test	800-1	2 min.	2½ min.	3½ min.
Monrad test	320-1	48 sec.	60 sec.	84 sec.
Harris test	128-1	19 sec.	24 sec.	33 sec.
Acidimeter	--------	20% acid	18% acid	16% acid

Electrometric measurements of the pH concentration in whey during the making process did not indicate significant changes in acidity any more accurately than did the ordinary acidimeter test. (Jour. Dairy Sci., 17 (1934) p. 33.)

(50A) Several Uses for the Rennet Test. Rennet tests are used most commonly to measure the ripeness of milk in the

cheese vat. To compare the strength of an old lot and a newly purchased lot of extract make a test on a vat of milk using the old lot of rennet, and immediately make another test with all conditions the same but using the new lot of rennet. Duplicate tests agreeing well with each other give the maker greater confidence in his results.

Another occasional use is to test samples of each patron's milk to see whether any milk is being delivered, which will not (12) curdle well with rennet. Different test cups may be compared.

(51) Hot Iron Test. The acidity of curd is measured also by the length of fine silky threads formed on contact with the hot iron. For this test a clean iron bar or piece of gas pipe, two or three feet long is heated, under the boiler or in a flame, so that one end is scorching hot, while the other end can be held in the hand.

A small block of curd with a smooth cut surface is taken in the right hand, and a suitable hot place on the iron is selected by touching a corner of the curd to the iron at spots between the middle and the hot end. Instant blackening of the curd indicates too high temperature for the test, and where the curd does not blacken at all the iron is too cold. Where the curd sticks and turns dark brown or black in about 5-10 seconds the temperature of the iron is about right. The flat surface of the curd block is applied to the iron at this point for two or three seconds, and then drawn steadily away, noting the length of the fine, not coarse, threads at the time when most of them have broken in two. By resting the iron and the hand on a brick, the curd can be moved steadily, and the maximum length of threads observed, depending on the acid in the curd. The whey is drawn when the threads are about 1/8 inch long, and the curd is salted when the threads are 3/4 to 2 inches long, according to the cheesemakers choice.

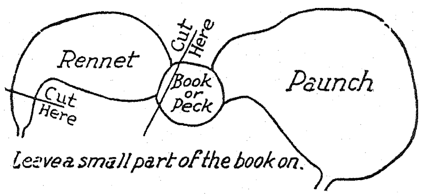
The hot iron test requires skill to handle it correctly, and some curds which are quite dry or contain too much acid may fail to show it on the hot iron. The test is said to have been invented by Mr. L. M. Norton, of Goshen, Connecticut, in 1845.

CHAPTER VII.

Calf Stomachs, Rennet, Pepsin, Color, Etc.

(52) Save Calf Stomachs. Cheesemakers, farmers and butchers should see that stomachs are saved for use in cheesemaking. Directions for preserving calf stomachs in suitable condition for shipment and use can be obtained on request from the Marschall Dairy Laboratory, Madison, Wis., or from The Chris. Hansen Laboratory, Little Falls, N. Y., and Milwaukee, Wis., or from others who make rennet extract for sale.

(53) Preservation of Stomachs. To obtain stomachs having the greatest strength for cheesemaking the calves should be milk fed exclusively, 2 weeks or more of age, and hungry for



Calf Stomach. Cut off the fourth stomach from the third stomach, so as not to lose any of the upper end, which is most valuable.

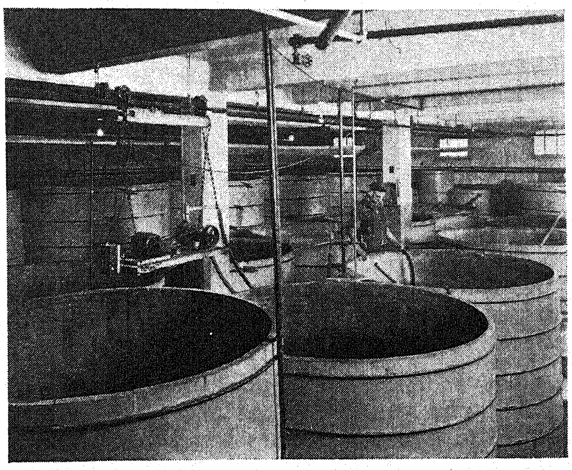
about 10 hours when butchered. Calves shipped a long distance by freight are usually inferior for this purpose. As soon as butchered, the rennet or fourth stomach is removed with care to retain all of its upper "book" end, where the food enters, as this part is strongest in coagulating power. The stomach is squeezed to expel its contents, and any adhering fat or other tissue is taken off of the outer surface. The inside should not be washed. The ends may be tied with string, the stomach blown full of air, and hung up in a cool airy place, protected from flies, to dry for several days. When well dried, they are folded flat, packed in bundles, and shipped in boxes.

Instead of blowing full of air, the stomachs may be split open, stretched, sprinkled with plenty of dry salt, and left on an inclined board to drain and dry, with occasional stretching and salting. The well salted and drained stomachs may be shipped to the buyer when a sufficient number are collected.

(54) The Making of Rennet Extract. As American cheesemakers now generally prefer to buy commercial extract in kegs or jugs, the process of making will be described only briefly. The

dried stomachs are chopped up in a shredding machine, and put to soak in salt brine containing also some boric acid as a preservative. After several days, more salt is added, and the liquid is filtered clear, and stored in a cool, dark place. After sufficient ageing, it is tested and brought to a definite strength for sale to the cheesemaker.

Rennet extract made by the cheesemaker at the factory every few days varies greatly in strength. There is more or less trouble and waste in using it and soon it may spoil. It is impossible to make satisfactory rennet tests with extract varying in strength from day to day. Most makers prefer to buy fresh extract of uniform quality from a manufacturer or dealer, three or four times a year, or oftener so as to avoid loss of strength in long storage (61).



Modern Manufacture of Rennet Extract. Courtesy Marschall Dairy Laboratory, Madison, Wis.

(55) Keeping Quality of Rennet. When first made, well cooled rennet extract loses about 1% strength per month during the first month or two, but after that it keeps its strength with only very slight loss for a long period. On that account, extract makers store it at the factory for the first few months, and bring it to standard strength before it is sold.

It keeps its strength better in the dark than in the light, and is therefore commonly sold in jugs, kegs, or brown bottles. It keeps better when cool, and is therefore stored in the coolest part of the factory. Heated to 140 degrees, the extract loses its coagulating strength quickly, and less rapidly at 120 degrees. In neutral solution, it will stand heating better than in acid solution but it cannot be sterilized by heat without entire loss of strength.

Therefore rennet extract is best sterilized, when necessary, by addition of formalin. Dry rennet powder can be sterilized by heat.

Diluted rennet extract may lose strength rapidly hence, it is diluted only when needed for use. Never pour water or diluted extract back into the jug or keg.

Alkaline substances of any kind added to rennet almost instantly destroy its coagulating power. Hence vessels in which rennet extract is handled should be free from soap or washing powder. The glass graduate used for measuring cheese color, a strongly alkaline liquid, should not be used also for extract without thorough washing. Separate graduates are preferable (61B). Just how rennet causes milk coagulation is not fully understood. (Soc. Exptl. Biol. & Med. Proc., 1924, p. 301.)

(56) Other Rennet Products. Besides rennet extract there are also in the market rennet paste or powder put up in tin cans, and rennet tablets or junket tablets. The powder is dissolved in water and added to the milk. The paste is softened or thinned with water, and squeezed through a cloth for Italian cheese. The tablet can be bought in small size suitable for a quart of milk (178), or in large size for 100 pounds or more of milk. The tablets keep well and are especially useful where cheese is made only occasionally.

A dozen dried calf stomachs are often tied up in a roll, called a "wurst," or are sometimes chopped fine and packed in a pasteboard tube, for use by Swiss cheese makers, who cut off an inch or more daily as required for making "lab" (61).

(57) Pepsin as a Rennet Substitute. During a period of scarcity of stomachs and rennet extract, pepsin made from hog stomachs from the packing houses has been sold as a substitute, either in the form of fine powder, or coarse powder, or in thin scales called "scale" pepsin, or in solution. The dry pepsin was weighed out by the cheesemaker at the rate of about ¼ ounce per thousand pounds of milk, or sometimes measured, as ¼ ounce by weight of the different dry products occupy ½ to ¾ ounce by volume in a glass graduate. The dry pepsin is dissolved in luke warm water, and the solution is added to the milk in place of rennet extract.

Pepsin intended for cheesemakers' use should be tested for its strength in curdling milk instead of on egg white.

As a substitute for rennet, pepsin solution is not altogether satisfactory. If milk is ripened to about .20% acidity, ¼ ounce of good dry pepsin will thicken the milk about as soon as 3½ ounces of rennet extract, but where sweeter milk is used, as in the making of Swiss, Limburger, and at many factories making brick or American cheese, this quantity of pepsin does not thick-

en the milk so well as does the rennet extract. For sweet milk, makers therefore used pepsin little or not at all.

(58) Coagulation and Curing. Pepsin products, labeled 1-3000, to show their strength in dissolving (digesting) boiled egg white, were found to differ widely in their strength for coagulating milk. This difference between coagulating strength and digestive strength again indicates what has long been suspected, that pepsin (and rennet) contain two "enzymes," one of which coagulates milk, and another which takes part in cheese curing.

More recently (1935) it was reported that the coagulating power of pepsin was reduced to 1/50th or 1/20th by different degrees of temperature, but the digestive action on milk proteins was not reduced. (Jour. of Dairy Research, Sept. 1935, page 419; Dairy Research Institute, New Zealand, Pub. No. 62.)

(59) Other Substitutes for Rennet. In past centuries, cheesemakers have made use of the stomachs of lambs, hares, kids, and other animals for thickening milk, and also the juices of certain plants, as the thistle, and of the leaves of the fig tree, and in more recent times a number of plant juices have been found to have milk curdling properties. None of these substitutes has found practical use in modern cheese factories.

(60) Standard Strength of Rennet Extract. The standard is difficult to state in exact terms, but 3 ounces of a full strength fresh extract have been known to thicken 1,000 pounds of perfectly fresh, sweet milk in 45 minutes, at 86 F., or 1,000 lbs. of milk of .18% acidity in 15 minutes, at 86 degrees F.

(61) Making Whey Rennet. Many Swiss cheese makers now use commercial rennet extract, but formerly they made whey rennet, or "lab," daily at home. For this purpose, dried, blown rennets (53) are purchased at the beginning of the season. Two dozen stomachs are examined carefully, and any dirty, or foul smelling parts, as well as the useless lower ends of the stomachs, are removed. The stomachs are tightly rolled together in the form of a sausage or "wurst" 1½ to 3 inches in diameter, and 1 or 2 feet long. A piece of twine is wrapped spirally around them, binding them together tight. If moistened with a little salt water, the stomachs pack more closely, but care must be used to dry out the moisture afterward in a well ventilated place. Each day, a half inch or more, as found necessary, is cut off from the end of the "wurst," and used for making whey rennet or "lab."

"Lab" was made by putting the necessary amount of cleaned calf stomach (61) into a jar (about 1 gram stomach for 100 lbs. milk), adding a teaspoonful of good sour or old lab and a little water, and after soaking for a time, adding heated (202D) and

cooled, albumen free whey, to the jar, and holding at 86 degrees F. (24 R.), which is the best temperature for ripening lab. Casol sometimes added to the lab is intended to check the growth of the gas forming germs which every calf stomach is likely to contain. Lab may develop .4 to 1.3% acidity. An incubator should be used for the best results.

(61A) Cheese Color. This is made from the seeds of the annatto tree which grows in tropical climates. The seeds are cov-

Annatto Leaves, Pods, and Seeds.

ered with a red powder, which is dissolved in a strong lye solution to form cheese color, or in an oil to form butter color. These solutions are brought to a standard strength for the factoryman's use. Cheese color keeps well if not frozen. If a sediment forms it should not be shaken up for use.

Dairy

CHAPTER VIII.

The Composition of Milk, Whey and Curd

(62) Percentage Composition of Milk. Since milk was by nature intended for the nourishment of the calf, one might assume that it contains all the food elements necessary for building up the animal body. Analysis reveals the presence of water, which is absolutely necessary for the maintenance of life; ash is needed for the bones; nitrogenous material in the form of casein and albumen, etc., nourishes the muscles, hair, hoofs and horns; and carbonaceous matter in the form of sugar and fat maintains the heat of the body. Vitamines stimulate growth and various body functions.

The milk given by a fresh cow during the first few days after calving is called colostrum. It contains a large proportion of albumen, and such milk although fresh and sweet will curdle on boiling. It is not fit for cheesemaking, as it will not curdle well with rennet, but it is needed by the calf.

The composition of a cow's milk, as well as the quantity produced, depends upon the individuality and breed of the cow, and upon the period of lactation, the milk becoming somewhat richer as the calf becomes older. Conditions as to health, feed, shelter, etc., are also of importance, and may cause sudden variations in the composition of milk.

	Average	Minimum	Maximum
Specific gravity (60° F.)	1.032	1.029	1.036
Water	87.4 per ct.	92.0 per ct.	80.0 per ct.
Fat	3.7 per ct.	2.3 per ct.	7.8 per ct.
Casein	2.5 per ct.	1.9 per ct.	3.8 per ct.
Albumen	.7 per ct.	.6 per ct.	.8 per ct.
Milk Sugar	5.0 per ct.	3.5 per ct.	6.0 per ct.
Ash	.7 per ct.	.6 per ct.	.9 per ct.
		100.9	99.3

In the milk from different breeds of cows and other animals, the composition averages about as follows, according to various authorities. For goat milk, see U. S. D. A. Tech. Bul 671.

Breed	Fat per cent	Total Solids per cent	Casein per cent
Jersey	5.75	15.0	3.0
Guernsey	5.0	14.5	2.7
Brown Swiss	4.0	14.0	2.6
Ayrshire	3.85	13.0	2.5
Shorthorn	3.6	12.5	2.4
Holstein	3.5	12.0	2.5
Sheep	6.5	18.0	4.6

Breed	Fat per cent	Total Solids per cent	Casein per cent
Goat	6.0	16.0	3.0
Buffalo	7.5	18.0	4.3
Reindeer	17.0	32.0	8.4
Camel	2.75	13.0	3.5
Horse	1.2	9.0	1.3
Human	3.8	12.5	.9

As the differences among different breeds of cows are due to environment and inheritance, wide variations from the average may be found in a single breed, as low as 2.8 or 3.0 per cent of fat in Holstein milk in certain Swiss cheese producing regions. Wide variations often occur in a single herd, due to individuality of cows, although they receive the same feed and care. The sizes of fat globules are largest when cows are fresh. (Vermont bul. 341.)

Differences in fat content between successive milkings may be as large as 1 or 2%, especially if the intervals between milkings are unequal. Thus, with a long day period and a short night period, the morning milk is likely to be richer in fat. The first portion of a milking is lower in fat, and the last portions or strippings are much richer in fat than the average, but there is less variation in the solids-not-fat. (Jour. Dairy Res. 5 (1934) 123.)

During the first month or two of the lactation period, the flow and fat test are apt to be slightly higher than during the long middle period of nearly steady composition and milk flow. Toward the close of the lactation period, the milk flow decreases and the fat and casein percentages increase. The flow and test of milk are often affected by disease, changes or lack of feed, weather changes, exercise, excitement, fright, "heat," drugs, etc.

Milk production sometimes can be driven above the usual level by feeding more protein than usual, although the gain may not be profitable. Feeds rich in vegetable oils, as corn oil, linseed meal, etc., may or may not affect the melting point of butter fat, but pasture grass or gluten feeds rich in fat are likely to lower the melting point.

The content of milk sugar in milk is affected very little by changes in feed, and ranges from 4.5 up to 5% for cow milk, and from 4.5 to 6.0 for other animals listed above, excepting reindeer milk which contains about 2 per cent, and human milk which may contain over 6 per cent lactose. Milk sugar is produced in the mammary gland from lactic acid and glucose. (Jour. Dairy Sci. (1938) No. 5, 168.)

On account of the differences among cows as to annual milk flow and butter fat production, resulting in profit or loss, the modern practical dairy farmer keeps records of milk flow and fat test for each cow, or joins a cow testing association, discards

unprofitable cows, breeds to "bred and tested" bulls, and feeds according to production to make his herd more profitable (91).

(62A) Proportions of Fat and Casein in Milk and Cheese. Different milks used for cheesemaking may contain .5, .6, .7, or .8 lb. of casein for each pound of fat present in the milk. (64A)

An extra pound of milk fat going into cheese increases the weight of the cheese by exactly one pound, but an extra pound of milk casein increases the weight of the cheese by 2.5 to 2.75 or more pounds, since each pound of casein carries with it into cheese 1.5 to 1.75 or more pounds of moisture in order to make the cheese of the desired body or firmness.

These facts are of importance in the selection of cows to produce cheese factory milk, since the milk that contains one pound less fat and one pound more casein, will yield about 1.5 to 1.75 lbs. more cheese. Thus by selection of cows whose milk contains enough fat (but not more), and enough casein (but not less), to put a legal content of fat into cheese, the largest possible weight of cheese is obtained from the feed given to the cow, and the largest profit to farmer and cheesemaker.

The very general use of Holstein cows throughout cheese factory areas is in accord with these facts (68D). To teach these facts to patrons is often an important task for the maker.

(63) Constitution of Milk. In milk, the milk sugar, albumen, and about half of the ash are dissolved in the water present. Dry milk sugar is white and crystalline, but not so sweet as cane sugar. It is used in medicine, in foods for infants and invalids, primost, etc. The fat is not dissolved, but is distributed through the milk in the form of very small drops, called fat globules.

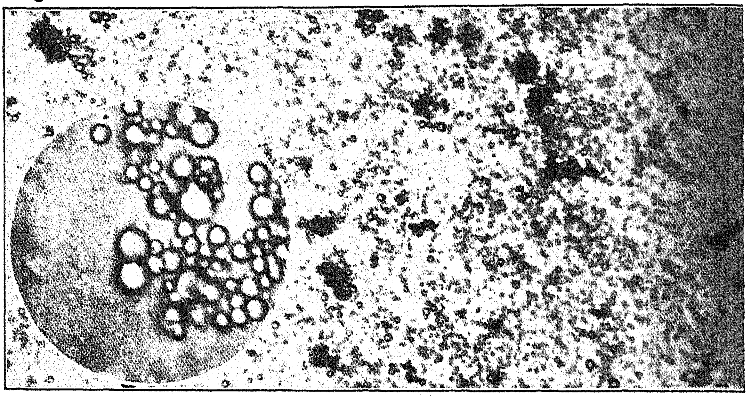
(64) Casein. The casein is the part of the milk that is curdled by rennet or weak acids. It is classed as a protein.

The casein in milk is partly but not fully dissolved in the water present. It is distributed in very much smaller particles than the fat globules, so that the casein particle cannot be seen under the ordinary microscope, neither do they settle to the bottom on standing, or rise to the top like fat globules. Yet it is certain that casein is not fully dissolved in milk, for if milk be filtered through a porcelain filter it will leave a gelatinous mass on the filter, which contains casein; or, if skim milk be revolved for a long time in a separator bowl, a layer of slime containing casein will be deposited.

Casein in milk is like egg-white, glue, and blood, in that all four of these substances, while fluid at first, may be thickened to a jelly or clot. Thus egg white hardens on heating, gelatine or glue is fluid when hot, but hardens on cooling, while blood

thickens or clots upon exposure to the air, and casein may be thickened, coagulated, or curdled by acids or by rennet. The ratio of fat to casein in milk is of importance to the cheese-maker (205).

Casein, under different conditions, carries different proportions of moisture, forming a solid or liquid mass. In milk, the ratio is about 1 of casein to 40 of water. Cottage cheese casein carries 3½ to 4 lbs. of moisture per lb. of casein, in the form of a fairly solid curd. With a little alkali added, it turns into a gluey



The fat globules as seen through a microscope. The portion in the circle is more highly magnified. The globules vary from 1-2000 to 1-40,000 of an inch in diameter, and as many as 150,000,000 globules are present in one drop of milk.

liquid. In American cheese, 1 lb. of casein carries about 1.5 to 1.75 or more lbs. of water, combined with it, forming a firm or a soft cheese. The higher ratio of moisture to casein promotes bacterial growth, hastens curing, and shortens the life of cheese, before it spoils.

The proportions of casein in mixed milk vary with the fat test, but not in the same proportion as the fat test. The casein percentage in any cow's milk may also vary from day to day with changing conditions of weather, feed, etc. The average variations found by the writer in Wisconsin station herd milks in 1917-1919 are represented thus:

Fat test, %	3.0	3.5	4.0	4.5	5.0
Casein, %	2.14	2.27	2.40	2.53	2.66
Lbs. casein per lb. fat	.71	.65	.60	.56	.53
Lbs. fat per lb. casein	1.40	1.54	1.67	1.78	1.88

(64A) For Average Milk, Van Slyke published the following:

Fat test, %	3.0	3.5	4.0	4.5	5.0
Casein, %	2.1	2.3	2.5	2.7	2.9
Lbs. casein per lb. fat	.7	.66	.62	.60	.58

(65) Albumen. Casein is not the only protein in milk. If sour whey or other dilute acid is added to whey at about 180 degrees F., another precipitate will be thrown down. This is albumen. It is in solution like white of egg until the heat and acid precipitate it. Albumen is not incorporated in Cheddar cheese in the ordinary method of manufacture, and apparently cannot be so incorporated without producing sour cheese. (305)

In addition, small amounts of other components are present in milk, but our knowledge of them is as yet incomplete.

(66) Distribution in Curd and Whey. When milk is mixed with rennet in the cheese vat, the casein thickens, and the thick curd surrounds and holds the fat globules. After cutting or breaking into small pieces, the curd may give up about 95% of the moisture present, which goes to form whey, carrying with it the same proportion of the water soluble materials, milk sugar, albumen, etc.

The distribution of milk constituents between curd and whey is about as shown in the diagram, for American cheese.

MILK
- Water 87.4%
- Total Solids 12.6%
  - Solids Not Fat 8.9%
    - Milk Sugar 5%
    - Albumen .7%
    - Ash .7%
    - Casein 2.5%
  - Fat 3.7%

WHEY
- 95% of the water, dissolved milk sugar, albumen, etc.
- 5% of the casein, or less.
- 10% or less of the fat.
- About half of the ash.

CHEESE
- 90-95% of the fat.
- 95% of the casein, or more.
- About half of the ash.
- About 5% of the water, dissolved milk sugar, and albumen.

(67) Composition of Whey and of Curd. The average composition of whey and of curd from the whole milk American cheese vat may be represented about as follows:

	Whey	Curd
Fat, per cent	.35%	34%
Casein	.10	23
Albumen	.75	--
Water	93.00	37
Milk Sugar	5.00	
Ash	.80	6
	100.00%	100%

Many American cheese factories have as little as .20% fat in the whey, which they recover as whey cream. At others, the whey fat percentage may be .35 to .45%. Swiss cheese whey contains .5 to .9% fat, or sometimes more.

CHAPTER IX.

Composition of Cheese, Yield, Quality and Price. Standardization

(68) How Milk Fat Affects Yield. In normal milk from cows in different herds, the fat test may vary, and with it the casein percentage, and also the ratio of casein to fat in the milk, as follows:

Milk fat test, %	3.0	3.5	4.0	4.5	5.0
Casein content, %	2.1	2.3	2.5	2.7	2.9
Ratio, casein/fat	.7	.657	.625	.6	.58

To estimate the cheese yield from 100 lbs. of each milk, add

						Totals
9/10 of milk fat, lbs.	2.7	3.15	3.6	4.05	4.5	18.0
Milk casein, lbs.	2.1	2.3	2.5	2.7	2.9	12.5
Salt, ash, lbs.	.3	.35	.4	.45	.5	2.0
Dry matter, lbs.	5.1	5.8	6.5	7.2	7.9	
38.6% moisture, lbs.	3.2	3.65	4.1	4.55	5.0	20.5
Cheese yield, lbs.	8.3	9.45	10.6	11.75	12.9	53.0
Cheese per lb. fat	2.77	2.70	2.65	2.61	2.58	

(68A) Milk Fat and Cheese Quality. Normal variations in the composition of milk affect the fat content of cheese, but have little or no influence on the market quality of cheese, excepting that cheese very high in fat content may appear soft, and may be supposed mistakenly to be high in moisture. The same market price is paid for all good, marketable cheese, without reference to its fat content, if within legal limits. Early students of cheese manufacture observed that whole milk cheese are superior to skim milk cheese in flavor quality, as well as in food value and price per pound. Based on such observation, it is argued by some at present that between legal cheese from high and low fat milks, the former must necessarily be the better of the two in quality, because of its higher fat content, and should bring a higher price per pound. On the other hand, the small proportion of high fat milk at cheese factories, the small amount of high fat cheese in the markets, and the difficulty of distinguishing high fat cheese, excepting by analysis, have created no special recognition or demand from consumers, and no advanced price for such cheese.

(68B) How Moisture Affects Yield. From a vat of about 1,000 lbs. milk, a maker of export American cheese got 100 lbs. cheese, which on being tested was found to contain 34% moisture. Subtracting 34% from 100% gives 66% dry matter in the cheese. Multiplying 66% by the weight of the cheese, 100 lbs.,

gives 66 lbs. of dry matter in the cheese. What weight of cheese would be obtained from the same milk, if the cheese contained 37, 40, 43 or 47% moisture?

(1) Lbs. cheese weighed.	(2) % Moisture.	(3) % dry matter.	(4) Lbs. dry matter.	(5) Lbs. cheese calculated.	(6) Kind of cheese.
100 lbs.	34%	66%	66 lbs.		Export
	37%	63%	" "	104.76	Storage
	40%	60%	" "	110.00	Colby
	43%	57%	" "	115.8	Brick
	47%	53%	" "	124.5	Limburger

Since the same weight of dry matter, 66 lbs. will go from this vat of milk into any cheese, regardless of moisture content, it is necessary only to divide 66 lbs. by the % of dry matter (column 3), which gives in column 5 the weight of cheese calculated for that moisture % (column 2).

(68C) How Moisture Affects Quality. Since bad flavor in cheese is largely due to the kinds of bacteria present, and since high moisture promotes the growth and activity of bacteria, it is to be expected that high moisture cheese from unclean or overripe milk will develop unclean or acid flavors sooner and to a greater extent than if the cheese has been made drier. (68P)

On those days when the patrons fail to deliver a good, clean milk supply, the maker must decide whether it will be more profitable (1) for him to make a 39% moisture cheese and take a cut in selling price, or (2) to make a drier, firmer cheese (about 36%) and thus take a loss of about 5 lbs. cheese per 100 lbs of cheese sold (68B), and perhaps avoid cut price.

In so far as a maker follows (1), the buyer is loaded up with high moisture cheese of poor quality, although he may prefer drier cheese of better quality.

(68D) Price Figured on Moisture Basis. To encourage the manufacture of drier cheese, when necessary to secure good quality, cheese buyers in certain markets have adopted the plan of paying (for cheddars and flats) the market price for 38% or 39% moisture cheese, and adjusting the price per pound upward in proportion to the decreased yield (68B) as the moisture percentage goes down, thus paying the same amount of money for a vat of cheese as if the moisture content were 38% and sold at the market price.

By this plan, the buyer obtains a larger supply of drier cheese, and the factory suffers no loss of income from making drier cheese, either accidentally or intentionally. This plan is not used with smaller shapes than the flat, nor with inferior quality. The moisture test is determined at the laboratory, for each vat of cheese. See the following table.

TABLE OF CHEESE PRICES ON MOISTURE BASIS, OR "DRY BASIS."

MARKET	39.0%	38.0%	37.5%	37.0%	36.5%	36.0%	35.5%	35.0%	34.5%	34.0%	33.5%	33.0%
.12000	.1200	.1200	.1229	.1239	.1249	.1259	.1269	.1278	.1288	.1298	.1308	.1318
.12125	.1213	.1213	.1242	.1252	.1262	.1272	.1282	.1292	.1302	.1312	.1322	.1331
.12250	.1225	.1225	.1255	.1265	.1275	.1285	.1295	.1305	.1315	.1325	.1335	.1345
.12375	.1238	.1238	.1268	.1278	.1288	.1298	.1308	.1318	.1329	.1339	.1349	.1359
.12500	.1250	.1250	.1280	.1291	.1301	.1311	.1321	.1332	.1342	.1352	.1362	.1373
.12625	.1263	.1263	.1293	.1304	.1314	.1324	.1335	.1345	.1355	.1366	.1376	.1386
.12750	.1275	.1275	.1306	.1317	.1327	.1337	.1348	.1358	.1369	.1379	.1390	.1400
.12875	.1288	.1288	.1319	.1329	.1340	.1351	.1361	.1372	.1382	.1393	.1403	.1414
.13000	.1300	.1300	.1332	.1342	.1353	.1364	.1374	.1385	.1396	.1406	.1417	.1428
.13125	.1313	.1313	.1344	.1355	.1366	.1377	.1388	.1398	.1409	.1420	.1431	.1441
.13250	.1325	.1325	.1357	.1368	.1379	.1390	.1401	.1412	.1422	.1433	.1444	.1455
.13375	.1338	.1338	.1370	.1381	.1392	.1403	.1414	.1425	.1436	.1447	.1458	.1469
.13500	.1350	.1350	.1383	.1394	.1405	.1416	.1427	.1438	.1449	.1460	.1471	.1482
.13625	.1363	.1363	.1396	.1407	.1418	.1429	.1440	.1452	.1463	.1474	.1485	.1496
.13750	.1375	.1375	.1409	.1420	.1431	.1442	.1454	.1465	.1476	.1487	.1499	.1510
.13875	.1388	.1388	.1421	.1433	.1444	.1455	.1467	.1478	.1490	.1501	.1512	.1524
.14000	.1400	.1400	.1434	.1446	.1457	.1469	.1480	.1491	.1503	.1514	.1526	.1537
.14125	.1413	.1413	.1447	.1459	.1470	.1482	.1493	.1505	.1516	.1528	.1540	.1551
.14250	.1425	.1425	.1460	.1471	.1483	.1495	.1506	.1518	.1530	.1541	.1553	.1565
.14375	.1438	.1438	.1473	.1484	.1496	.1508	.1520	.1531	.1543	.1555	.1567	.1579
.14500	.1450	.1450	.1485	.1497	.1509	.1521	.1533	.1545	.1557	.1569	.1580	.1592
.14625	.1463	.1463	.1498	.1510	.1522	.1534	.1546	.1558	.1570	.1582	.1594	.1606
.14750	.1475	.1475	.1511	.1523	.1535	.1547	.1559	.1571	.1583	.1596	.1608	.1620
.14875	.1488	.1488	.1524	.1536	.1548	.1560	.1573	.1585	.1597	.1609	.1621	.1633
.15000	.1500	.1500	.1537	.1549	.1561	.1573	.1586	.1598	.1610	.1623	.1635	.1647
.15125	.1513	.1513	.1549	.1562	.1574	.1587	.1599	.1611	.1624	.1636	.1649	.1661
.15250	.1525	.1525	.1562	.1575	.1587	.1600	.1612	.1625	.1637	.1650	.1662	.1675
.15375	.1538	.1538	.1575	.1588	.1600	.1613	.1625	.1638	.1651	.1663	.1676	.1688
.15500	.1550	.1550	.1588	.1600	.1613	.1626	.1639	.1651	.1664	.1677	.1689	.1702
.15625	.1563	.1563	.1601	.1613	.1626	.1639	.1652	.1665	.1677	.1690	.1703	.1716
.15750	.1575	.1575	.1613	.1626	.1639	.1652	.1665	.1678	.1691	.1704	.1717	.1730
.15875	.1588	.1588	.1626	.1639	.1652	.1665	.1678	.1691	.1704	.1717	.1730	.1743
.16000	.1600	.1600	.1639	.1652	.1665	.1678	.1691	.1705	.1718	.1731	.1744	.1757
.16125	.1613	.1613	.1652	.1665	.1678	.1691	.1705	.1718	.1731	.1744	.1758	.1771
.16250	.1625	.1625	.1665	.1678	.1691	.1705	.1718	.1731	.1745	.1758	.1771	.1784
.16375	.1638	.1638	.1677	.1691	.1704	.1718	.1731	.1745	.1758	.1771	.1785	.1798
.16500	.1650	.1650	.1690	.1704	.1717	.1731	.1744	.1758	.1771	.1785	.1798	.1812
.16625	.1663	.1663	.1703	.1717	.1730	.1744	.1758	.1771	.1785	.1798	.1812	.1826
.16750	.1675	.1675	.1716	.1730	.1743	.1757	.1771	.1784	.1798	.1812	.1826	.1839
.16875	.1688	.1688	.1729	.1742	.1756	.1770	.1784	.1798	.1812	.1825	.1839	.1853
.17000	.1700	.1700	.1741	.1755	.1769	.1783	.1797	.1811	.1825	.1839	.1853	.1867
.17125	.1713	.1713	.1754	.1768	.1782	.1796	.1810	.1824	.1838	.1852	.1867	.1881
.17250	.1725	.1725	.1767	.1781	.1795	.1809	.1824	.1838	.1852	.1866	.1880	.1894
.17375	.1738	.1738	.1780	.1794	.1808	.1823	.1837	.1851	.1865	.1880	.1894	.1908
.17500	.1750	.1750	.1793	.1807	.1821	.1836	.1850	.1864	.1879	.1893	.1907	.1922
.17625	.1763	.1763	.1805	.1820	.1834	.1849	.1863	.1878	.1892	.1907	.1921	.1935
.17750	.1775	.1775	.1818	.1833	.1847	.1862	.1876	.1891	.1906	.1920	.1935	.1949
.17875	.1788	.1788	.1831	.1846	.1860	.1875	.1890	.1904	.1919	.1934	.1948	.1963
.18000	.1800	.1800	.1844	.1859	.1873	.1888	.1903	.1918	.1932	.1947	.1962	.1977
.18125	.1813	.1813	.1857	.1872	.1886	.1901	.1916	.1931	.1946	.1961	.1976	.1990
.18250	.1825	.1825	.1869	.1884	.1899	.1914	.1929	.1944	.1959	.1974	.1989	.2004
.18375	.1838	.1838	.1882	.1897	.1912	.1927	.1943	.1958	.1973	.1988	.2003	.2018
.18500	.1850	.1850	.1895	.1910	.1925	.1941	.1956	.1971	.1986	.2001	.2016	.2032
.18625	.1863	.1863	.1908	.1923	.1938	.1954	.1969	.1984	.1999	.2015	.2030	.2045
.18750	.1875	.1875	.1921	.1936	.1951	.1967	.1982	.1998	.2013	.2028	.2044	.2059
.18875	.1888	.1888	.1934	.1949	.1964	.1980	.1995	.2011	.2026	.2042	.2057	.2073
.19000	.1900	.1900	.1946	.1962	.1977	.1993	.2009	.2024	.2040	.2055	.2071	.2086
.19125	.1913	.1913	.1959	.1975	.1990	.2006	.2022	.2037	.2053	.2069	.2085	.2100
.19250	.1925	.1925	.1972	.1988	.2003	.2019	.2035	.2051	.2067	.2082	.2098	.2114
.19375	.1938	.1938	.1985	.2001	.2016	.2032	.2048	.2064	.2080	.2096	.2112	.2128
.19500	.1950	.1950	.1998	.2014	.2030	.2045	.2061	.2077	.2093	.2109	.2125	.2141
.19625	.1963	.1963	.2010	.2026	.2043	.2059	.2075	.2091	.2107	.2123	.2139	.2155
.19750	.1975	.1975	.2023	.2039	.2056	.2072	.2088	.2104	.2120	.2136	.2153	.2169
.19875	.1988	.1988	.2036	.2052	.2069	.2085	.2101	.2117	.2134	.2150	.2166	.2183
.20000	.2000	.2000	.2049	.2065	.2082	.2098	.2114	.2131	.2147	.2163	.2180	.2196
.20125	.2013	.2013	.2062	.2078	.2095	.2111	.2128	.2144	.2161	.2177	.2194	.2210
.20250	.2025	.2025	.2074	.2091	.2108	.2124	.2141	.2157	.2174	.2191	.2207	.2224
.20375	.2038	.2038	.2087	.2104	.2121	.2137	.2154	.2171	.2187	.2204	.2221	.2237
.20500	.2050	.2050	.2100	.2117	.2134	.2150	.2167	.2184	.2201	.2218	.2234	.2251
.20625	.2063	.2063	.2113	.2130	.2147	.2163	.2180	.2197	.2214	.2231	.2248	.2265
.20750	.2075	.2075	.2126	.2143	.2160	.2177	.2194	.2211	.2228	.2245	.2262	.2279
.20875	.2088	.2088	.2138	.2155	.2173	.2190	.2207	.2224	.2241	.2258	.2275	.2292
.21000	.2100	.2100	.2151	.2168	.2186	.2203	.2220	.2237	.2254	.2272	.2289	.2306
From To	39.0 38.3	38.2 37.8	37.7 37.3	37.2 36.8	36.7 36.3	36.2 35.8	35.7 35.3	35.2 34.8	34.7 34.3	34.2 33.8	33.7 33.3	33.2 32.8

(68E) Comparison of Losses from Cut Price and from Low Yield. The difference in price per lb. of cheese, between "State Brand" quality and "standard brand" quality was usually .5 cent.

The loss in weight of cheese resulting from a decrease of 3% moisture is at least 4.76%, and the loss in cash is therefore 4.76% (or more) of the market price, per pound of cheese.

(1) Market Price, cents	21.	20.	16.	15.	11.	10.
(2) 4.76% Loss, cents	1.00	.95	.76	.71	.52	.476
(3) ½ cent cut, cents	.5	.5	.5	.5	.5	.5
(4) ¾ cent cut, cents	.75	.75	.75	.75	.75	.75
(5) 1 cent cut, cents	1.00	1.00	1.00	1.00	1.00	1.00

Comparing lines (2) and (3) shows that when the market price of cheese is above 10 cents per pound, there is less loss to the factory income by making a wet cheese and taking ½ cent cut in price, than by making a cheese with 3% less moisture, and taking a 4.76% loss in yield. Also, the maker's pay is based on the weight of cheese made.

If the difference in price between "first" and "second" quality brands were set at ¾ cent, then whenever the market price is above 16 cents, the loss is less by making the wet cheese and taking the cut price, as seen by comparing lines (2) and (4).

If the difference in price between "state' and "second" quality were set at 1 cent, then at any cheese market price below 21 cents, the factory income loss would be smaller by making the drier cheese, with a loss in yield of 4.76%, as seen by comparing lines (2) and (5). This discussion applies to any American cheese not sold on the "moisture basis" (68D).

Other factors also affect the choice between ½, ¾, and 1 cent as the cut in price between "state" and "standard" quality cheese.

(68F) Herd Cheese Yield Figured from Vat Yield and Milk Tests. A problem in every cheese factory is to learn what part of the vat cheese yield, and what share in the cheese sales money, is due to the herd milk of each patron. Herd milk is never made separately into cheese, excepting in rare laboratory experiments, one of which is described below. The yield of cheese from each herd and the patron's payment are therefore figured by some "system" which is acceptable to the herd owners.

The quality of every herd cheese is assumed to be the same as that of the vat cheese. Although one patron's milk may be thought to be the cause of inferior quality in a vat of cheese, no factory method has been devised to penalize defective milk, other than to send it home. All milks admitted to the vat are truly pooled as to clean quality. But see (17).

(68G) Pooling. In the early days, all herd milks in the vat were "pooled" as to yield, assuming that 100 lbs. milk from any one herd would give the same weight of cheese as 100 lbs. of milk from any other herd. This ancient "pooling system" is now generally abandoned, since it is unfair, and promotes watering or skimming. The milk was weighed but not tested.

53 lbs. vat yield of cheese was distributed to herds as follows, for example:

Patron No.	1	2	3	4	5
Lbs. milk delivered	100	100	100	100	100
Lbs. cheese credited to herd	10.6	10.6	10.6	10.6	10.6

(68H) Straight Fat. Testing each herd milk's composite sample for fat makes it possible to figure the cheese yield from each herd (and each patron's pay) in proportion to the weight of fat in each herd milk. This system is easy to understand and to figure. It makes skimming or watering unprofitable, and is used almost universally.

53 lbs. vat yield of cheese is distributed among herds as follows, for example:

Patron No.	1	2	3	4	5
Lbs. Milk delivered	100	100	100	100	100
Milk fat test	3%	3.5%	4.0%	4.5%	5.0%
Lbs. fat in milk	3.	3.5	4.0	4.5	5.0
(Total fat in milk, 20 lbs.)					
" x 53/20 equals herd yield	7.95	9.27	10.6	11.93	13.25

(68I) Fat Plus Casein, by Test. Use of the Walker or Hart casein tests on each herd milk, in addition to the fat test, permits herd yields (and payments) to be figured in proportion to the added weights of fat and casein in each herd milk. The use of the Hart test for this purpose has been abandoned. The use of the Walker test, with some refinements, has been proposed by McDowall in his system of "costed payments" (New Zealand Jrnl. Sci. & Tech., Vol. 18, p. 336, Aug. 1936).

(68J) Fat Plus Calculated Casein. Avoiding the labor of testing all herd milks for casein, Van Slyke prepared a table of "average" casein tests, showing a casein test to be added to the fat test of each herd milk (64A).

53 lbs. vat yield is distributed among herds as follows, for example:

Patron No.	1	2	3	4	5
Lbs. milk delivered	100	100	100	100	100
Fat test of milk	3.%	3.5	4.0	4.5	5.0
Van Slyke "average" casein test	2.1	2.3	2.5	2.7	2.9
Sum of fat and casein %	5.1%	5.8%	6.5%	7.2%	7.9%
Lbs. fat and casein in herd milk	5.1	5.8	6.5	7.2	7.9
(Total fat and casein, 32.5 lbs.)					
" x 53/32.5 equals herd yield	8.3	9.45	10.6	11.75	12.9

Or, if the cheese is all assumed to contain (32.5/53) 61.32% dry matter and 38.68% moisture, divide as follows to get the herd milk yields.

Lbs. fat plus casein in herd milks	5.1	5.8	6.5	7.2	7.9
" divided by 61.32% gives yield	8.3	9.45	10.6	11.75	12.9

(68K) Fat Plus .6%. Later, Sammis showed that the same cheese yields can be figured by adding .6% to each milk fat test.

53 lbs. vat yield is distributed among herds as follows, for example:

Fat test of milk, %	3.0%	3.5%	4.0%	4.5%	5.0%
Adding .6%	.6	.6	.6	.6	.6
Sum	3.6%	4.1%	4.6%	5.1%	5.6%
Lbs. "fat plus .6" in herd milk	3.6	4.1	4.6	5.1	5.6
(Total "fat plus .6" equals 23 lbs.)					
" x 53/23 equals herd yield	8.3	9.45	10.6	11.75	12.9

(68L) Fat Plus 2%. The Canadian method of figuring herd yields from the milk fat tests is as follows:

Fat test of milk	3.0	3.5	4.0	4.5	5.0
Adding 2%	2.0	2.0	2.0	2.0	2.0
Sum %	5.0%	5.5%	6.0%	6.5%	7.0%
Lbs. "fat plus 2." in herd milk	5.0	5.5	6.0	6.5	7.0
" x 53/30 equals herd yield, lbs.	8.8	9.7	10.6	11.5	12.4

(68M) How Herd Milks Behave, When Mixed in a Vat. Herd milks are tested for fat, casein, or in other ways, and weighed, to determine what weight of cheese solids, fat and casein, each herd milk has contributed to the vat yield of cheese, as a basis for figuring the yield (or payment) for each herd milk.

An important question remains. How much of the 20.5 lbs. of moisture in the vat cheese (above) should be credited to each herd milk and cheese? Van Slyke's view was that the percentage of moisture should be considered uniform in all herd cheese, the same as in the vat cheese, giving yield figures as in (68J).

(68N) Sammis and Germaine (Butter and Cheese Journal, Sept. 25, 1929, p. 13) suggested that the moisture content of each herd cheese should be proportional to the casein content, or to the fat free solids of the cheese. This has been further discusssed by McDowall (New Zealand Jrnl. Sci. & Tech., Vol. 18, p. 272, Aug. 1936). To illustrate the effect of this proposal on figured herd yields, for the five patrons:

Milk fat test, %	3.0%	3.5%	4.0%	4.5%	5.0%
Lbs. fat in cheese	2.7	3.15	3.6	4.05	4.5
Lbs. (average) casein	2.1	2.3	2.5	2.7	2.9
Lbs. ash, salt in cheese	.3	.35	.4	.45	.5
Lbs. dry matter	**5.1**	**5.8**	**6.5**	**7.2**	**7.9**
Less fat in cheese	2.7	3.15	3.6	4.05	4.5
Lbs. fat-free solids	2.4	2.65	2.9	3.15	3.4
(Total fat free solids equal 14.5 lbs.)					
(Total moisture, 20.5 lbs. in 53 lbs. cheese)					

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20.5/14.5 equals 1.41					
Lbs. fat-free solids x 1.41 equals					
Lbs. moisture	3.38	3.74	4.09	4.44	4.79
Add lbs. dry matter	5.1	5.8	6.5	7.2	7.9
Lbs. herd yield	8.48	9.5	10.6	11.6	12.7
Or, with moisture proportional to casein,					
(Total casein equals 12.5 lbs.)					
(Moisture, 20.5 lbs.)					
20.5/12.5 equals 1.64					
Lbs. casein x 1.64 equals lbs. moisture	3.44	3.77	4.1	4.43	4.76
Lbs. herd yields	8.54	9.57	10.60	11.63	12.66

These herd yield figures are proportional to the milk fat test plus 1.14.

% Moisture in herd yield	40.40%	39.27%	38.68%	38.20%	37.8%

(68O) The question remains to be tested experimentally if possible. In a vat of mixed milk, does each herd cheese retain moisture in proportion to its content of casein, or fat free solids, with cheese moisture percentages lower from high test milk, as in (68N), or is the moisture percentage uniform in the herd cheese yields, as in (68J)?

To throw light on this, the composition of milk used, and the yield and composition of American green cheese as taken from the press, determined by three seasons cheesemaking experiments at the Wisconsin Station by Sammis, et al., but never published, is represented by the following figures:

Milk test—					
Fat, per cent	3.0	3.5	4.0	4.5	5.0
Casein, per cent	2.14	2.27	2.4	2.53	2.66
Cheese, green, yield, lbs.	8.91	9.79	10.67	11.55	12.43
Cheese, Composition—					
Moisture, per cent	41.15	40.26	39.37	38.48	37.50
Casein, per cent	23.58	23.02	22.47	21.91	21.36
Fat, per cent	30.44	31.86	33.28	34.70	36.12
Ash, by difference, per cent	3.70	----	4.61	----	5.25
Ratio moisture to casein	1.745 to 1	----	1.752 to 1	----	1.759 to 1
Per cent fat in dry matter	51.7	----	54.8	----	57.8
Total solids	58.85	----	60.63	----	62.41
Fat plus casein	54.02	----	55.75	----	57.48
Cured yield, about, lbs.	8.4	----	10.1	----	11.8
Per 100 lbs. fat, about	280	----	252	----	236
Ratio moisture to fat-free solids	1.448	----	1.439	----	1.426

The milks used came from the University herds of Holsteins, and of Jerseys and Guernseys, all kept, fed, and milked in the same barn, by the same men, and all properly fed. The milk was kept clean and well cooled, in separate cans from the two herds. In two vats at the Dairy School, it was made up into cheese by the same methods exactly, as to all details, to show if possible what occurs when high or low testing milks have been mixed together in the factory cheese vat. The moisture-casein ratio remains equal in the two cheese. The milk and cheese were analyzed in the agricultural chemical laboratory. The scoring of the first season's cheese showed the high and low fat cheese to be practically alike in quality. The yields are proportional to the milk fat test plus 2.06. The high and low fat milks in two separate vats, handled alike, retained approximately the same ratio of moisture to casein, in the two cheese produced. If these

results can be substantiated by the work of other investigators, it would appear that all herd cheese should be figured to contain the same ratio of moisture to casein as found by analysis in the vat cheese, instead of the same percentage of moisture in all, in figuring herd cheese yields from a vat of milk.

(68P) On a related question, Sammis and Germaine (Butter and Cheese Journal, Sept. 25, 1929, p. 13) reported a series of cheese made, in two vats each day, from mixed and divided milk, made (so far as possible) with equal moisture percentage in the pair, but with varying legal fat and casein percentages, so that with increasing fat % in the dry matter of the cheese, the ratio of moisture to casein increased. The variations in fat content of the two milks daily were obtained by use of a cream separator. The cheese were weighed and tested green.

Composition and Scores of 78 Experimental Cheese

Group No.	Number of Cheese	Ratio M/SNF	Average Score	% Fat in Dry	% Moisture
1	9	1.66	78.71	59.29	40.9
2	10	1.55	81.42	58.99	39.0
3	16	1.45	83.91	56.88	38.4
4	17	1.32	85.09	51.74	38.8
5	14	1.27	86.21	50.48	38.6
6	13	1.19	88.16	52.13	36.3

Omitting groups 1 and 6 (if necessary) it is seen that the scores decreased with increasing fat content, and with simultaneous increase of ratio of moisture to casein. Probably no one would wish to argue that the scores decreased because of increasing fat percentage in the cheese. It is obvious that whatever effect the fat had on quality, the increasing proportion of moisture to casein was the governing factor which caused lowering of quality score. The milk supply used was from country farms, of rather unclean quality, and not selected, which probably accounts for the low scores on all the cheese.

The influence of a high fat content in cheese, towards improvement in quality, if any, is less potent than the influence of a high moisture-to-casein ratio towards reduction of quality, with milk of unclean quality. This confirms the views of many makers that to get fair quality cheese from unclean milk, it is safer to make lower moisture cheese, rather than high moisture cheese.

(68R) The Factory Patrons' Choice. The range of herd milk fat tests at a factory is discussed in the Van Slyke system (68J) as extending from 3% up to 5%, thus including herds of both low test and high test breeds. In the great majority of cheese factories are kept only cows of a single low test breed, so that the lowest and highest herd milk fat tests differ only by ½ or ¾% fat, instead of 2%.

At a few factories, having 3%, 4% and 5% milks at the same time, the straight fat method of figuring indicates differences in yield from 7.95 lb. cheese for 3% milk, up to 13.25 lbs. cheese for 5% milk.

Herd Milk Test %	3.0	3.5	4.0	4.5	5.0
Straight Fat Yields	7.95	9.27	10.6	11.93	13.25
Fat Plus .6% Yields	8.3	9.45	10.6	11.75	12.9
Fat Plus .2% Yields	8.8	9.7	10.6	11.5	12.4

This wide difference in yield (and payment) frequently causes great dissatisfaction among the low test patrons at such a factory, who claimed that the high test milk could not make so much cheese, and who have been known to leave the factory in a body, nearly wrecking the factory business. This is one good reason for keeping herds of fairly uniform milk fat test, at any factory.

The cause of the trouble lies in the wide spread of the milk fat tests at the factory, and not in the straight fat method of figuring yields or payments. At the great majority of factories, the straight fat method has long been used with entire satisfaction, and no doubt will be continued for a long time. At such factories where milk tests differ only by ½ to ¾% fat between the highest and lowest at the factory, the yields differ from 8.2 up to 9.6 lbs. cheese per 100 lbs. milk, and such differences excite no controversy.

If the milk tests are	3.0%	3.25%	3.5%	Totals
and the dry matter, lbs.	5.1	5.45	5.8	16.35
and moisture, lbs.	3.26	3.48	3.71	10.45
the yields, lbs. are	8.36	8.93	9.51	26.80

The distribution of 26.8 lbs. among the herds by three methods gives:

Straight fat	8.24	8.93	9.62	26.79
Fat test plus .6	8.35	8.93	9.51	26.79
Fat test plus 2.	8.51	8.93	9.36	26.80

Comparison of the three yield figures shows that, at such a factory, the difference between 8.24 and 8.35 amounts to only 1.1 cents per dollar, and between 8.51 and 8.35 amounts to 1.9 cents per dollar. At such a factory, it makes little difference which one of the three plans is used in figuring herd yields or milk payments, and the straight fat method, being simplest and best known is used quite generally.

(68S) Cheese Yield and Factory Competition. As long as the straight fat method of figuring is used, the "price per lb. fat" at each factory will attract the attention of patrons. The yield figures given above show that high test milk yields less cheese per pound of fat than does low test milk.

Milk fat test	3.0%	4.0%	5.0%
% fat in cheese dry matter	50-51%	53-54%	56-57%
Yield, per 100 lbs. milk, about	8.3 lbs.	10.6 lbs.	12.9 lbs.
Yield, per lb. of fat in milk	2.77 lbs.	2.65 lbs.	2.58 lbs.

These differences in % fat in the dry matter, and in cheese yield are due to the variations in

the casein content of milk	2.1%	2.5%	2.9%
and the lbs. casein per lb. fat	.7	.62	.58

Casein is important because each pound of casein may carry with it into cheese 1.50 lbs. moisture for a firm cheese, and 1.75 lbs. moisture in a soft, high moisture cheese.

Thus 1 lb. of fat from raises the yield	3% milk	4%	5%
for the added fat, lbs.	1. lb.	1.	1.
for the added casein, lbs.	.7	.62	.58
for added moisture, lbs.	1.05-1.22	.96-1.12	.87-1.02
a total gain of, lbs.	2.75-2.92	2.58-2.74	2.45-2.60
average gain, lbs.	2.83	2.66	2.52

This is an important reason why most cheese factory milk is well below 5% in fat, and why the great majority of patrons prefer to keep cows of one of the low fat test breeds.

If at one factory, the average milk fat test is considerably higher than at a neighboring competing factory, the high test factory must expect to have a lower yield per lb. of fat delivered, throughout the year, and pay a correspondingly lower price per lb. of fat.

With cheese at 20 cents per lb., and before deducting expenses, the price per lb. of fat is........56.6 cents 53.2 cents 50.4 cents

On this account, a maker should inquire, before buying a factory, as to the average milk fat test at this factory, and at neighboring or competing factories. Makers also should watch the patrons' milk tests, and advise patrons interested in herd improvement, that high production of lbs. milk, and lbs. butter fat, (and not high test milk) is what makes a herd more profitable, and that low test milk enables the factory to meet competition from neighboring factories, as to price of butter fat.

(69) Current Moisture Standards. When the early Wisconsin legal standards for moisture in American cheese were being formulated in 1916, 567 samples of American cheese from dealers in all parts of the state were collected at the Wisconsin Experiment Station, and tested for moisture. On comparing the moisture tests with the dealers' judgment on each sample, as to its quality, it was found that 40% moisture before July 1, and 39% after July 1, was the limit of moisture for good, salable cheese, suitable for our principal markets at that time. The Canadian cheese supplied in large quantities to the British market shows a remarkably high degree of uniformity and quality,

because of the careful methods of manufacture, and partly because of the low moisture content, 34 to 36%, which tends to promote uniform good quality.

Wisconsin cheese for the southern markets contain about 37 to 38% moisture and are quicker curing than the Canadian product, while yet firm enough to stand the warm climate where they are marketed.

Cheese containing 39 to over 40% moisture made in Wisconsin previous to the establishment of moisture standards, often developed serious faults in storage, or did not stand up in the warmer climates, and frequently caused dealers a great deal of trouble and loss. Such cheese are fit only for immediate sale and consumption in those cooler northern states, where they are permitted to be manufactured (chapter 27). Only the very cleanest milk can be made into high moisture, good quality cheese.

(69A) Increasing Commercial Use of Standards. In recent years, the increasing acquaintance of farmers with cow testing methods and results, the increased use of milk fat tests and lactometer at factories, and the increasing use of cheese moisture and fat tests at warehouses, have all contributed toward the elimination of sub-standard cheese from commerce. Every maker should know the moisture test of his cheese in each vat.

(70) Fat Standards. Under federal rules, and the laws of many states, whole milk cheese must contain at least 50% of fat in the dry matter (77). Thus a cheese containing 38% moisture, and 62% dry matter must contain at least 31% of fat in the cheese. Using normal whole milk and normal methods of manufacture, there is little danger of any factory's product running below this fat standard, and most American cheese contains at least 51% of fat in the dry matter. Whole milk cheese if well made from either Holstein or Jersey milk sell equally well, and at the same price, without any attention being paid to the fat content, if legal. (N. Z. Dept. Sci. Ind. Res. bul. 9, p. 60.)

In Wisconsin, the legal limit of fat in the dry matter of Swiss cheese is 45%, being lower than for American cheese, on account of (1) the greater loss of fat in Swiss cheese whey, which may be .5% to .9% or more, and (2) the need for avoiding short or "glass" texture which may result from too much fat, or other causes in the cheese. A 1937 Wisconsin law to permit 43% of fat in the dry matter of Swiss cheese may go into effect, under certain conditions.

Twenty-one samples of imported Swiss cheese from the retail markets analyzed at Wisconsin by the writer averaged 48.15% fat in the dry matter, and the lowest was 43.30%. Thirty samples of domestic Swiss averaged 51.33%, and the lowest was 46.56%.

In earlier years, before the present laws were passed in Wisconsin, requiring skim milk cheese to be distinguished by its shape, 10 inches in diameter and 9 inches high, a great deal of competition arose between whole milk and skim milk American cheese, the latter was often fraudulently substituted for the former, and the quality of the latter was distinctly inferior owing to the small percentage of fat present in the skim cheese. Since the skim milk cheese law was passed, few of the special sized skim milk cheese hoops have been used in Wisconsin. The question as to the relative quality of whole milk cheese made from 3% or from 4% milk has not proven of sufficient importance to attract the attention of consumers, or cheese dealers, one market price being established for all without reference to the fat content of the cheese, so long as it is within the legal limit. Standardization is often practised where lawful.

(71) Standardization of Milk for Cheesemaking, Where Legal. In many states where legal, standardization of milk is used to bring milk to such a content of fat and casein as will give cheese of the desired percentage of fat in the dry matter. As normal milk may be often too high in fat, (and seldom, if ever, too low,) the simplest method of standardization is to remove part of the fat (or casein) from the milk by means of a separator. Other methods instead of removing fat, may be the addition of skim milk, or of condensed skim milk, or of skim milk powder. The latter two methods are seldom used, because of the cost of materials. (Nat. B. and C. Jrnl., Dec. 1939, p. 16)

(72) Possible Profits from Standardizing. Makers of cheese containing 39% moisture may correctly figure that for each pound of fat taken from milk for cheesemaking, there is a loss of 1.6 lbs. in cheese yield. With a loss of 1.6 lbs. cheese, at 20c per lb. or 32 cents loss, and selling 1 lb. of fat in cream at 50 cents, there is apparently a profit of 18 cents If the pound of fat had not been skimmed out, .1 lb. of it would have been found in the whey cream. There is therefore only .9 lb. fat gained for sale, worth 45 cents, which with 32 cents cheese yield loss, leaves 13 cents profit, per pound of fat skimmed out in the standardization process, before expenses are paid.

The keeping quality of legal 39% moisture cheese is likely to be improved and not lowered by taking part of the fat out of high fat milk, testing 4 to 5% fat. The improvement in quality results from the fact that for every pound of fat taken out of the milk made into cheese, six-tenths (.6) of a pound of water must also be taken out to keep the cheese at the 39% moisture limit set by law. This is illustrated by the following figures. 100 lbs. of normal 4.5% milk will make 11.75 lbs. of legal cheese containing 39% moisture as in column (a).

	(a)	(b)	(c)
Milk fat, lbs.	4.5	3.5	3.5
Casein, lbs.	2.7	2.7	2.7
Fat in cheese, lbs.	4.05	3.15	3.15
Casein in cheese, lbs.	2.7	2.7	2.7
Ash and salt, lbs.	.4	.4	.4
Moisture, lbs.	4.57	4.57	3.99
Weight of cheese	11.72	10.82	10.24
Moisture, %	39.0	42.2	39.0
Ratio of moisture to casein	1.7 to 1	1.7 to 1	1.5 to 1

In column (b) we have taken one pound of fat out of the milk. The cheese is yet legal as to fat, the cheese weighs .9 lbs. less, but the moisture figures out 42.2%, which is beyond the legal limit. The weight of moisture must be reduced, as is done in column (c).

In column (c) we have taken .6 lb. moisture out of the cheese, reducing the moisture to 39%, as required by law.

The above shows why the removal of 1 lb. of fat from milk where legal makes it also necessary to remove .6 lb. moisture from the 39% moisture cheese, thus reducing the ratio of moisture to casein, and improving the keeping quality.

(72A) Method of Standardization of Milk for Cheesemaking (Where Legal).

To illustrate standardization methods for use where not unlawful, assume that the standardized milk should contain about .7 lb. of casein for 1 lb. of fat as follows:

Fat %	3.0	3.5	4.0	4.5	5.0
Casein %	2.1	2.45	2.8	3.15	3.5

Milk brought to the factory usually differs from the above, by either (1) containing too much fat, or rarely (2) too much casein and too little fat. The Babcock test and casein test are used in testing milk for fat and casein, after the entire quantity of milk is mixed in the vat. Divide the casein % by the fat %. If the quotient is .7, the milk needs no standardizing.

(1) If the quotient is less than .7, it is necessary to take out some fat in the form of rich cream. Suppose the vat tested 2.1% casein and 4% fat. To figure how much milk from the vat should be run through the separator, proceed as follows:

First, divide the casein % by .7. In this case, 2.1/.7 equals 3.0. This means that the milk should contain 3% fat, after standardizing. Subtract this figure 3.0% from the fat test 4%, which gives the difference 1% fat to be removed.

Second, multiply the weight of milk in the vat by the difference, 1%, and divide by the milk fat test 4%. With 3,500 lbs. of milk in the vat this gives 875 lbs. which is the weight of milk to be run through the separator.

Third, draw as rich a cream as possible from the separator and put all the skim milk back in the vat. Keep the cream out.

Finally, to prove your work, test the standardized milk for fat and casein again. Test your cheese after making it, for fat and moisture, to see if it contains at least 50% fat in the dry matter. The casein to fat ratio (.7) may be changed if desired after experience with it as a standard.

(2) If the quotient is larger than .7 it is necessary to take out some casein in the form of skim milk. This occurs rarely. Suppose the milk tested 2.45% casein and 3% fat.

First, to figure how much milk from the vat should be run through the separator, multiply the fat test by .7. In this case 3% x .7 gives 2.1% casein which the milk should contain after standardizing. Subtract this figure 2.1 from the milk casein test 2.45, which gives the difference .35% casein to be removed.

Second, multiply the weight of milk in the vat by the difference, .35, and divide by the milk casein test, 2.45%; with 3,000 lbs. of milk in the vat, this gives 429 lbs. which is the weight of milk to be run through the separator.

Third, draw as rich a cream as possible from the separator, and put all the cream back into the vat. Keep the skim milk out.

Fourth, mix well, and test the standardized milk for fat and casein. Test your finished cheese for fat and moisture.

(3) Sources of error. The milk weighing and testing should be done as accurately as possible. In (1) above, the 35 lbs. of skim milk taken out (in 50% cream) equals about 1% of the vat contents, reducing the casein ratio from .700 to .693, a negligible error.

In (2) above, the 13 lbs. of skim milk (in 50% cream) returned to the vat, raises the casein ratio from .700 to .704, a negligible error.

(72B) Standardizing by Guesswork. This is something attempted by makers having no casein test, by a cut-and-try method, based on a milk fat test alone. Thus if milk tests 4% fat or more, the maker guesses that about one eighth of the fat may be taken out by running one eighth of the milk through the separator, and returning the skim milk to the vat. Tests of the cheese thus obtained show whether the legal standard has been passed, and whether the proportion of milk then skimmed should have been greater or less. Only by testing milk for both

casein and fat can the correct and safe proportion of milk to be skimmed be calculated in advance. Tests on the finished cheese should not be neglected in any case.

(72C) Standardizing with Skim Milk Powder or Condensed Skim. If milk contains less than .7 lb. casein per lb. of fat, as in case of milk testing 4.% fat and 2.1% casein, which contains only .52 lb. casein per lb. of fat, proceed as follows:

Multiply the fat test by .7, in this case getting 2.8 as the casein % to be in the milk after standardizing. 2.8% less 2.1% gives .7%, the casein to be added. This means that .7 lb. casein is to be added to each 100 lbs. of milk. If skim milk powder contains 1/3 its weight of casein, then 3x.7 equals 2.1 lbs. skim milk powder to be added per 100 lbs. of milk. The powder must be quite fresh, and easily soluble in milk, so that it will not settle out and be lost in the whey. The casein content of powder varies.

Good quality condensed skim milk could be used in a similar way, if the percentage of casein in the material is known. The standardized milk will then presumably be pasteurized for cheesemaking. The cost of the powder used is often about equal to the value of the increase in cheese yield, leaving little or no profit. (Idaho Bul. 174.)

(72D) Standardizing by Adding Skim Milk. If skim milk of good quality can be purchased at a low figure, this method may be used. To calculate the weight of skim milk to be added, test the vat for fat and casein. Multiply the fat % by .7 to get the required casein %. Thus with 4% fat the required casein % is 2.8. Subtract the vat casein test, 2.2%, from 2.8%, leaving .6% casein to be added. Multiply the weight of vat milk, 5,000 lbs., by 6%, giving 30 lbs. casein to be added. Test the skim milk supply for casein (say 2.5%). Divide 30 lbs. by 2.5%, which gives 1,200 lbs. of fat-free skim milk to be added to the vat. It is often hard to find sweet, clean skim milk.

(72E) Adding Cream or Whey Cream.—In case that vat milk contains more than .7 lb. casein per lb. of fat, divide the casein test by .7, to find the required fat test of the standardized milk, subtract the actual fat test from the required test, and multiply the difference by the weight of milk in the vat to find the number of pounds of fat in cream to be added. Divide this weight of fat by the fat test of the cream, to find the number of pounds of cream to be added.

(72F) Standardizing in Large Factories (Where Legal). Large sized cheese factories, having large milk supplies and plenty of help and equipment, are far more likely to find stand-

ardizing practicable or profitable than small factories. Accurate testing of milk for fat and casein must be learned by the maker. Without careful, accurate work, standardizing cannot be successfully accomplished, but is likely to result in the production of more or less illegal, low-fat cheese. Cheesemakers are advised not to attempt standardization of milk in vats unless the tests and methods are thoroughly understood. The final step in the process is always the testing of the cheese for fat and moisture to see if it is within the legal limits. Cheesemakers who may be required to standardize in various states should learn how.

In a large plant, a tank full of skim milk may be prepared and tested, and a calculated amount of the skim milk is then added to each vat or kettle of whole milk for cheesemaking.

(72G) Effect of Errors. A difference of .1% in fat test or casein test of milk or in the fat loss in the whey makes a difference of 1.% fat in the dry matter of cheese.

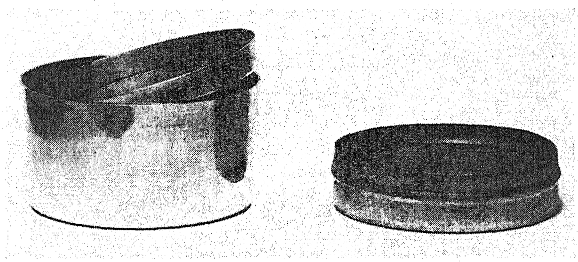
(72H) Standardizing in New Zealand, and America. By an overwhelming majority in 1931, New Zealand cheese producers decided that the manufacture and export of standardized cheese to England must stop. New Zealand makers in North Island receive practically nothing but Jersey milk. With the steady growth of high testing breeds in cheesemaking districts, two years trial was given to standardization of the milk down to 50-52% fat in the dry matter of cheese. But the mistake was made of branding the cheese with the word "standardized," with the result that any and all faults seen in the cheese quality were blamed on the standardization. In the welter of controversy which has taken place over the "standardization" issue, it has been difficult to separate fact from prejudice, but it is now generally admitted that the best of the standardized was equal in every respect to the full cream article. It is recognized that the cheese labeled "standardized" will not be received on its merits in the British markets.

Since April 9, 1941, U. S. federal regulations permit milk to be "adjusted" by separation of cream, or addition of cream or skim milk, for cheddar, colby, or washed-curd cheese. At present, Wisconsin law prohibits standardizing of milk for any cheese except Swiss.

CHAPTER X.

Cheese Tests for Moisture, Fat, Etc.

(73) Cheese Testing for Moisture. Every cheesemaker or wholesale dealer should test cheese for moisture so as to be sure his product is within the legal limit. The testing of cheese samples for fat by the Babcock test can now be done as quickly as cream testing.



Moisture test dishes.

(74) Cheese Moisture Testing Equipment. The moisture test scales, weights, etc., should conform to the legal requirements of the state or nation where used. The usual equipment for cheese moisture testing includes a modern torsion scales or similar scales sensitive to .1 gram (or less when new), a 5 gram and two ten gram weights, cheese sample bottles or covered tin boxes, covered moisture test dishes of aluminum, or tin salve boxes from the druggist, trier, dry quartz sand or other means of balancing each dish exactly, etc. The graduated beams on the scales permit of reading exactly the final moisture percentage up to 50%, without the use of a complete box of weights.

A butter moisture scale, reading up to 40% can be used, if a 1 gram weight (equal to 10% moisture) be placed on the right hand pan during the final reading of the moisture percent.

Cheese samples can be dried in a high pressure steam oven, a vacuum oven, or on top of the factory boiler, or over a kerosene lamp, but the rapid methods by which butter samples are dried over a flame in a few minutes are not yet generally applied to cheese. See Wisconsin circular 81. Also publications of the Wisconsin State Supt. of Weights and Measures, State Capitol, Madison, Wis. Also, Methods of Analysis, Official Agric. Chemists, Fourth Edition, 1935, p. 291.

(75A) Sampling Cheese for Moisture Test. One or more trier plugs are taken, so as to be representative of the whole cheese, keeping well away from old trier holes, the cheese rind, a cut surface, or a damaged spot. Return the outer end (¾ inch) of the trier plug to close the trier hole and seal with butter or cheese, or paraffine. Put the rest of the plug quickly into the cheese sample bottle, or tin box and apply the cover. Do not wrap plugs in paper or cloth, or leave exposed to the air. Such samples, packed to prevent breakage, may be shipped by mail to a central laboratory for testing.

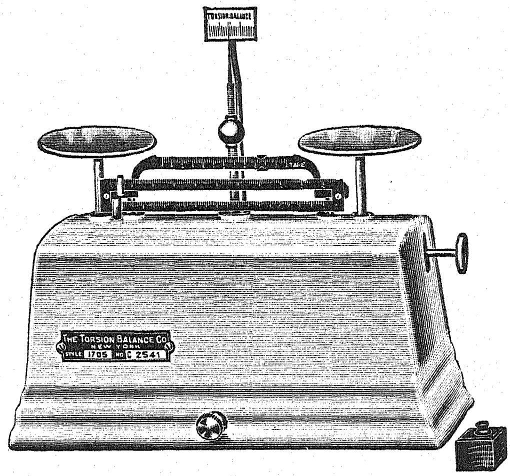
Cheese may be sampled after pressing one hour. The maker may object to plugging a new cheese from every vat for the tests. It has been found at the Wisconsin Station that this can be avoided by sampling the cheese just before dressing after it has been thoroughly pressed in the hoop for not less than one hour. For this purpose the bandage is pulled down a little at one side, and the trier is inserted horizontally into the side of the cheese. The trier hole made in this way will close entirely, leaving the rind perfect, when the cheese is left over night in the press. Samples of cheese taken in this manner from the curd in the hoop at night agree closely in moisture content with samples drawn from the same cheese next morning, after pressing for about 20 hours.

(75B) Weighing Cheese Samples for Moisture Test. It is advisable, for beginners at least, to make always two tests in two moisture dishes on the same cheese.

A 10 gram sample should be well dried in 4 or 5 hours at 50 lbs. or higher steam pressure. For makers who weigh out samples in the afternoon or evening, dry them next day, and weigh again late in the day, a 10 gram sample is preferred, but those who wish to complete a test in half a day or as soon as possible, may prefer to use 5 gram samples, which will require a five gram weight in the outfit.

First. When starting work each day, see that the scales are in a well lighted location, on a solid level shelf, window sill or table which will not shake or sag. Leaning on the shelf while weighing may throw scales out of balance. It is well to draw a pencil mark on the table around the scales, when in place, in order that afterward any accidental change in location may be detected at once. A wall case or a cover for the scales will protect it from dust, steam, or insects, etc.

Second. The well located scale is next balanced exactly while empty, and this must always be done each time just before weighing anything. In doing this, the sliding weights on



Modern Torsion Scales for Moisture Test.

all of the graduated beams are set at the zero marks, the heavy sliding weight is then moved to a position where the scales are almost exactly balanced, and the final adjustment is made with the levelling screws. The scale is in balance when the moving pointer swings equal distances (5 to 10 divisions) on both sides of the middle of the pointer scale.

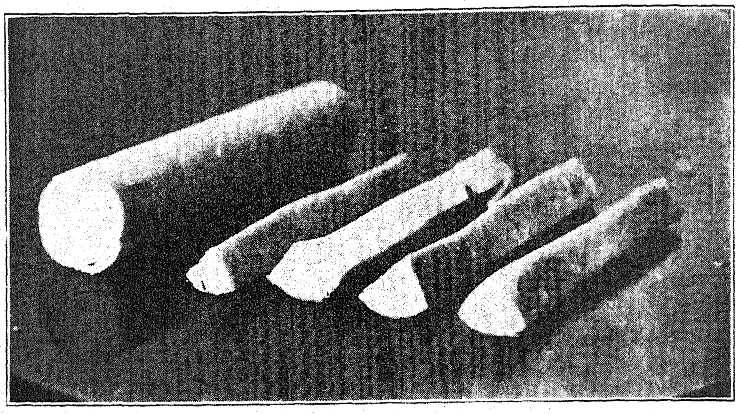
Third. With the scale properly balanced, an empty moisture sample dish is placed on the right hand pan, and a slightly heavier counter poise or slug is placed on the left pan. To make the dish balance the weight or slug, several methods may be used. The easiest and quickest is probably to add a little dry quartz sand to the dish until it is exactly balanced. This sand is not attacked by ordinary acids, and may be purchased from the White Rock Silica Co., 19 Curtis st., Chicago, in large or small quantities and dried in the steam oven for use in testing. This method has been used for years.

(Some testers trim all dishes with shears until they exactly balance the chosen weight or slug, or use the small tare beam and slide at the top of the scales, and record a tare for every empty dish, as well as its number.)

Fourth. Having a dish balanced thus, a 10 gram weight is added to the left hand pan, opposite the dish.

Fifth. The cheese sample bottle is opened and the sample plugs may be ground in a mortar and put back in the bottle for use. Or the sample plugs may be split in quarters, lengthwise,

with a sharp knife and if there is enough for two tests, one-half is quickly returned to the sample bottle. The other half, or as much as necessary, is added rapidly to the test pan on the right, until the scales are just balanced again, thus obtaining exactly



Cheese Sample Plug Cut into Strips for Testing.

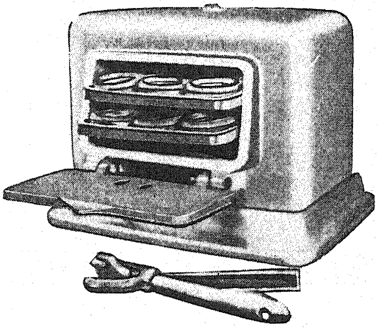
A long strip best represents the whole cheese. Chopping or grinding a plug into small pieces is unnecessary, and if done slowly, permits the loss of moisture before weighing.

10 grams of cheese in the dish. A second empty dish may now be balanced with sand, and 10 grams of cheese added from the sample bottle, if there is enough, thus making tests in two dishes (duplicates) on one sample of cheese, which is desirable in many cases.

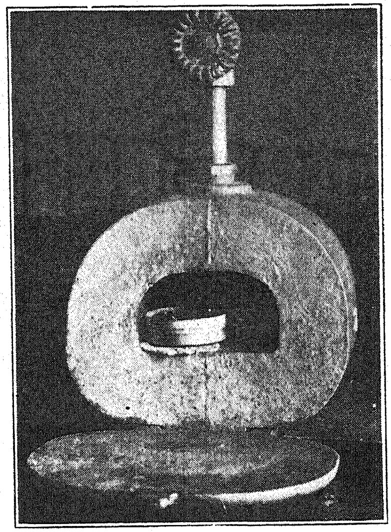
Each dish thus filled may be marked with a black lead pencil on the side, with the cheese sample number or the student's number. (If the tare beam was used in balancing the empty dish, the dish number, tare and cheese number must be recorded on paper for reference later, and each dish should carry a permanent number stamped on it. For this reason, the sand method seems simpler.)

Sixth. Cheese can be dried satisfactorily in the Wisconsin High Pressure Steam Oven, or on the boiler surface itself, using a 50-60 pound steam pressure for at least 4 or 5 hours, or in a longer time at a lower pressure. A small hot air oven over a kerosene lamp chimney, or some similar device, can be used for making a few tests at a time.

The temperature of steam is dependent on its pressure, as shown by the following table, and the temperatures to which samples are exposed inside the oven are slightly lower than these figures.



A Medium Sized Steam Oven.



A Small Sized Oven.

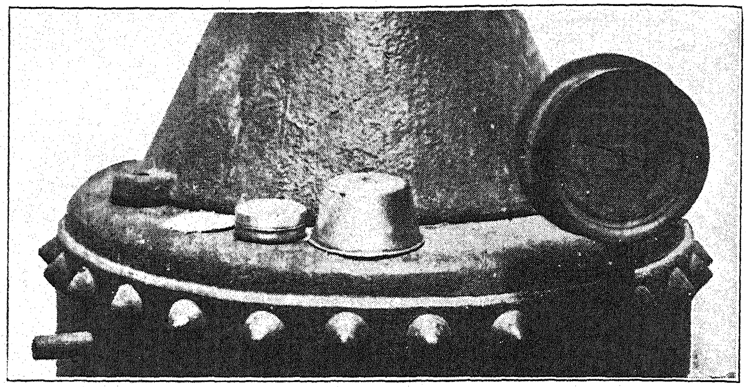
Gauge pressure lbs.,	10	20	30	40	50	60	70	80	90
Temperature, F.,	240	259	274	286	297	307	316	323	331

Electrically heated ovens are often used with automatic temperature regulation. Vacuum ovens, with an air pump (the outfit costing about $125) are occasionally used, for drying 10 gram samples in an hour or two at the temperature of boiling water, or exhaust steam.

With cheese a week old or more, it is seen that the dried samples have a yellow color, while samples from younger cheese turn darker brown or black in drying, on account of their milk sugar content.

It is better to place dishes on a wire shelf or on a piece of asbestos paper in the oven rather than directly on the hot iron itself. Cheese samples give off moisture rapidly at first and, if heated quickly to the highest oven temperature, the sample may boil violently or foam over, thus spoiling the test. To avoid this, leave the oven door partly open to admit air during the first hour of the heating.

The heating of 10 gram samples in the oven should be continued at least 4 hours with about 50-60 pounds steam pressure, and with a large oven full of samples the heat may well be continued for an hour or two longer. The oven door is kept closed after the first hour; this prevents cold air from entering, but



Drying Samples on the Boiler.

From left to right—a piece of asbestos paper, a moisture sample dish on a paper, and a tin pan to protect the sample from dirt and keep it warm. A small hole punched in the bottom of the pan lets the moisture escape freely.

permits water vapor from the cheese to escape readily because the door does not fit perfectly. With 30 pounds steam pressure about one hour longer is required; with 15 pounds from 8 to 10 hours or longer drying is needed to fully remove the moisture.

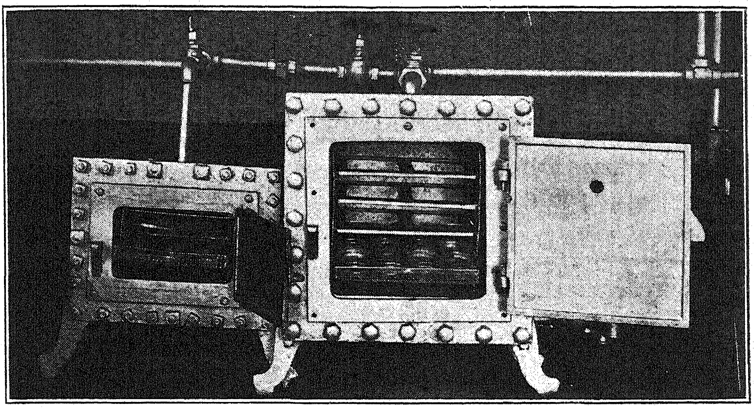
On removing hot dishes from the oven, they should be covered promptly and left to cool before weighing.

With new cheese it has been found that continued heating for several hours after the moisture has been driven out, causes only the very slightest loss in weight, amounting to about ¾ of one per cent in 24 hours, so that there is little or no danger of heating too long and the dishes may be left in the hot oven all day or all night, if more convenient.

Samples of old, cured cheese continue to lose weight with long continued heating somewhat more noticeably than do samples of fresh curd or green cheese, and are therefore heated only 4 to 6 hours at 50-60 pounds pressure.

Seventh. After the samples are dried, the percentage of moisture lost is determined as follows. Balance the empty scales as before. Put the same weights as before on the left hand pan. (If the small tare beam was used, set the tare slider as recorded for each dish, which is placed on the right hand pan.) Now push the sliding weights on the graduated beams from zero to the right, until the scales are exactly balanced. Read from the two beams, and the sum of these two readings is the per cent of moisture which the sample lost.

If using butter moisture scales, add a one gram weight to the right pan, and add 10% to the slider beam readings for the cheese testing.



Large Sized Steam Ovens.
This type of oven, having from 2 to 4 shelves, will hold from nine to sixteen 2-inch dishes on each shelf.

Eighth. Beginners should not fail to prove the completeness of the drying, no matter what heating device is used, by putting part or all of the samples back and heating them for another hour, and then giving them a final weighing, to be sure that they were completely dried.

Close agreement of the results of two tests made in separate dishes on the same sample of cheese indicates that no mistakes were made by the operator in the weighing of dishes and samples. Duplicate tests commonly agree with each other within ½ of one per cent moisture, or the tests should be repeated.

Since the correctness of a test depends to a great extent upon the skill and experience of the operator both in sampling and in weighing, it is recommended that duplicate tests be made on every sample of cheese tested by a beginner. If satisfactory duplicate tests are made, the average of the two is reported.

(75C) Rapid "Oil Test" for Moisture in Cheese. While oven tests may include many samples and require several hours time, a single sample may be tested accurately in about half an hour by the following method, which resembles the rapid moisture test for butter. The same scales are required, and also an alcohol lamp or blue flame gas burner.

A seamless, flat bottomed aluminum cup is used, about 2 inches in diameter, and 3 inches high, and preferably with no attached handle, or rivet holes in the side, since these are apt to leak fat. The cup is cleaned and placed on the right hand pan of the scales, after balancing them empty. A slug about 5 to 10 grams heavier than the dish is placed on the left pan. The scales are then exactly balanced by adding olive oil to the cup.

After placing a 10 gram weight on the left pan, the cheese sample is added to the cup, until the scales balance exactly.

Holding the cup in suitable tongs, the cup is rotated in and out of the flame of the alcohol lamp, until the cheese melts and the moisture comes out as steam from the gently boiling mass. By moving the cup in and out of the flame during each rotation, the temperature is controlled and no loss of solids occurs from the cup.

When the boiling stops, the cup is wiped on the outside and bottom with a cloth to remove any trace of soot, and after cooling a few minutes, it is placed again on the scales as when it was taken off. The scales are balanced with the sliding weights and the moisture percentage is read from the beams.

While this single sample requires continuous attention, it enables a maker or warehouse man to test a cheese for moisture the same day that the cheese was made.

Olive oil from any grocery store is used because it does not change its weight during the heating, and gives accurate results. (Jrnl. Dairy Sci. XX, Oct. 1937, p. 625; XXI, July 1938, p. 379-383.)

(76) **Testing Cheese for Fat by the Babcock Test.** The Babcock test for determining the fat content of milk and its products was invented by Dr. S. M. Babcock of the Wisconsin Experiment Station, and described in Bulletin No. 24, July, 1890; it is now in general use not only in this continent, but in different countries of Europe, in India, New Zealand and Australia. It has literally "gone around the world."

The older methods of dissolving cheese samples for the Babcock test consumed a great deal of time in softening samples in the test bottle by long soaking with warm water before adding acid. The following method devised by the author in 1909, and used without accident since that date, can be completed almost as quickly as an ordinary cream test. Journal Ind. Eng. Chem. 1909, p. **604.**

The sample of cheese, amounting to from 8 to 10 or 12 grams is placed in the 30% Babcock test cream bottle, and weighed with the same scales used in the moisture test, or with the usual cream test scales. 10 grams is preferred. Long narrow strips cut from the sample plug drop easily through the neck of the bottle (75B).

If the bottles used for this purpose are permanently numbered by etching on the side, and are weighed clean and dry, the list of weights can be used thereafter, whenever the bottles are clean, dry, and filled with a cheese sample, making it neces-

sary to weigh only the bottle with the sample, but not the empty bottle again.

The sample is dissolved rapidly in the following manner: Fill the acid measure to the mark with sulphuric acid as usual. From a dish of boiling water, place 10 c.c. of very hot water in the bottle with the cheese. Some testers prefer to use 12 or 15 c.c. of water at a temperature below boiling. Sometimes it is necessary also to dip the bottle into the boiling water for a few seconds, as explained below, to aid in securing a sufficiently high final temperature.

Immediately after adding the hot water, and without any delay whatever, begin adding the acid from the measure in small portions, rapidly, about 1 c.c. at a time, giving the bottle one quick shake after each addition, to mix the acid and water. When about half of the acid has been added in this way in small portions, the remaining half may be added in larger portions, or all at once.

As soon as the acid is all in, the bottle is shaken continuously, and the heat developed by mixing the acid with the hot water is sufficient to soften the cheese quickly, melt it to a liquid, and quickly dissolve all portions of it except the fat.

If the first sample thus handled proves to be a little slow in dissolving, the next bottle may be heated a little hotter by dipping the bottle in the boiling water for a few seconds before adding the 10 c.c. of water to the cheese.

While it may seem dangerous to suggest the addition of strong sulphuric acid to hot water, yet by adding small portions and mixing, as directed, the boiling point of the dilute acid is always higher than the temperature attained in the bottle, and in this way the work is done quickly without loss of material.

As in all Babcock tests, the neck of the bottle should be turned toward the wall while adding acid to avoid a possible accident from boiling over, but this seldom if ever occurs. A burnt test is never obtained. The fat column is clear.

The bottle is whirled and filled with hot water for reading like any cream test, and red reader is used. Dividing the bottle reading by the weight of the cheese sample, and multiplying by 18 gives the correct fat test of the cheese. Duplicate tests agree remarkably well if set in water at about 120 to 140 degrees F. for five minutes before reading. The older, slower methods of dissolving cheese in warm water before adding acid are seldom used at present. (Nat. B. & C. Jrnl., Aug. 1936.)

To test process cheese, add half of the acid, then cool the bottle and add the rest of the acid.

(77) Fat in Dry Matter. To calculate the percentage of fat in the dry matter, subtract the percentage of moisture from 100, and divide the percentage of fat by the remainder, which is the percentage of dry matter in the cheese. The quotient is the percentage of fat in the dry matter, and should be higher than 50% for all whole milk cheese, in Wisconsin, excepting Swiss for which the legal standard is 45%.

(77B) Hints on Fat Testing. Without attempting to fully describe milk or cream testing, the attention of the cheesemaker may be called to the following points, also (113):

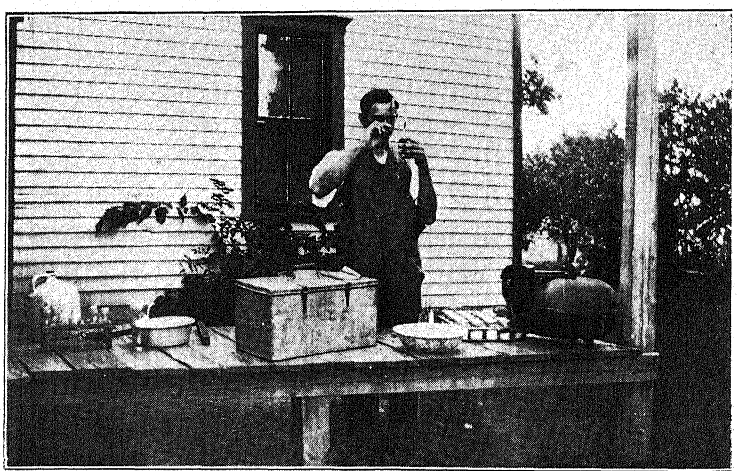
1. Accurate sampling is equally as important as skillful testing. Nebraska Circ. 53. Mich. Tech. Bul. 158.

2. Measuring acid in a pipette is a dangerous practice.

3. Having milk samples and acid too warm very often causes burnt tests. The acid jug may well be kept in the refrigerator in summer, and milk or whey samples in test bottles may be cooled in well water for a time before adding acid.

4. For uniformity and accuracy, it is well to set all milk tests in water at 135-140 degrees (120-125 degrees for cream tests) for five minutes before reading the per cent of fat. Always read milk tests to the top of the fat column meniscus.

5. A test committee of patrons, changed frequently, to be present when the maker does his testing, helps to keep patrons satisfied that the testing is done fairly. It also familarizes patrons with the test, and may lead them to undertake herd im-



Cow Tester at Work.

provement through cow testing and other means, and thus increase the factory milk supply.

7. Duplicate milk tests properly sampled and completed should always agree within .1% fat or less. Storrs Bul. 131 (1925).

8. To get clear whey fat tests, cool the sample in the bottle, in cold water. Add only about 2/3 of a measure of acid, avoiding any black or brown color.

(77C) Differences. Tests made on composite samples at the factory, and on cow tester's samples at the farm will probably differ, because at the farm one day's milk is tested, say on the first day of the month, but at the factory the composite sample over 14 days, may contain the milk of several fresh cows, of lower test, which came in after the first of the month. Makers should explain to patrons why these two samples may differ in fat test, and why the factory test is more accurate as a basis for payments.

(77D) Extraneous Matter in Cheese. A new method for this test is as follows: A mixture of 950 c.c. of 95% alcohol and 50 c.c. of hydrochloric acid, S. G. 1.18, is filtered before use. To 100 c.c. of this mixture, in a mortar, stir (not grinding) in a 50 gram sample of cheese (discarding the rind). Transfer to a 400 c.c. beaker, rinsing with 100 c.c. of the alcohol-acid solution. Heat slowly and boil three minutes. Filter through a No. 86 dreverhoff seven cm. filter paper in a Buchner suction funnel. Wash immediately with a large amount of boiling distilled water until the paper shows no cheese visible. Place the paper in a Petri dish and examine with about 40x magnification, or if necesarry transfer the debris from the paper to a drop of glycerine on a microscope slide and examine, with higher magnification.

In another form of test, 100 grams of cheese is weighed into a quart milk bottle, adding 200 c.c. of a solution of sodium citrate, containing 150 grams per litre. Then heat in a water bath at 140 degrees and stir at 1,000 R. P. M. for 15 minutes. Add 100 c. c. of water, and 100 c.c. of the citrate solution, and stir 30 minutes, until the cheese is fully dissolved. Divide the liquid in two parts and run each through a sediment test filter disc. J. Dairy Sci. 1938, p. 1-5. Wis. Bul. 439 (1937).

(77E) Testing New Cheese for Salt. 10 grams cheese (not over 5 days old) in a pint jar, with 250 c.c. distilled water, is heated to about 150 F., shaken well to mix, and cooled to room temperature. 17.6 c.c. of the clear liquid in a white cup, with

3 or 4 drops added of potassium chromate indicator (28 grams in 100 c.c. water) is titrated with silver nitrate solution (5.1 grams in 250 c.c. water) from a burette, to a red color. 1 c.c. of silver nitrate solution equals 1.% salt in the cheese. N. Y. Geneva Tech. Bul. 249.

Instead of chromate, a .1% solution of dichlorofluorescein in 70% ethyl alcohol is recommended as an indicator. Two drops are added to 25 c.c. of solution tested. Canadian Dairy and Ice Cream Jour. June 1937, Vol. XVI, No. 6.

CHAPTER XI

Cheese Judging and Scoring

(78) Judging Cheese Quality. The consumer who asks for a sliver of cheese to taste before making a purchase is the best judge as to whether its quality pleases him or not. Many men will approve a piece of cheese because of its snappy flavor, and disregard the fact that it is crumbly. Women may choose cheese which will cut neatly into squares, and not crumble on the table, even if the cheese is quite young and its flavor undeveloped.

As cheese production is seasonal, the warehouse man has to pass upon each vat of cheese as it comes from the factory, and select (1) those which appear to be free from defects and likely to remain so, to be put in cold storage for 3, 6, or 9 months, to supply the demand during the season of low production. He will (2) select vats of cheese which should be sold for immediate use, and ship them to fill current orders. (3) He may find certain lots of cheese which are more or less defective, and must be sold and eaten soon, as they may be expected to deteriorate rapidly. Possibly they may be bought and sold again at figures below the current market price, or they may be accepted from the factory, only on consignment, to be sold for whatever price they will bring.

This task of sorting lots of young cheese is a serious and difficult one, and mistakes may occur. For this reason, cheese put into storage are examined again about once a month, to see whether they are developing serious defects, and should be taken out of storage and sold immediately, before they spoil.

In a very young cheese, fresh from the factory, there may have been little development of real cheese flavor, and also little appearance of faults in flavor which may appear later, often due to certain harmful bacteria which got into the milk, and are yet alive in the cheese, but have not yet had time to do their work.

It is generally true that a defect in flavor which is slight at first, is likely to become more intense as time passes, and the sale value of the cheese decreases accordingly. The cheese judge observes the present quality and faults of a cheese, attempts to predict whether it will improve or not, and may try to explain the source or cause of the faults observed.

(78A) Cheese scoring consists of expressing the intensity of each fault in a cheese by a cut in the numerical score. Thus, on

the scale of 100, as perfection, a very good cheese might score 95 to 98, a good marketable cheese 92 or thereabouts, and an inferior cheese may score 88 or below. Numerical scores are necessary to decide the winners in competitions for prizes, etc. The cheese judge who can score cheese consistently, and put the same score repeatedly on a given cheese, without knowing that it is the same cheese, required long practice to develop this ability, and must carry in his mind very definite ideas as to what he means by the different scores he assigns to cheese.

Cheese scoring is learned by continued working with an experienced judge, and a surprising degree of agreement may be developed as a result of such work, long continued.

The score cards widely used for American cheese are: Make up 20, color 10, texture 40, flavor 30, total 100. Formerly it was flavor 45, texture 30, color 15, make up 10, total 100.

For brick and Limburger the following card is used: Flavor 40, texture 40, color 10, salt 5, package 5.

For Swiss cheese, the Wisconsin score card is: Flavor 35, holes 30, texture 20, salt 10, package 5.

The Canadian score card for Cheddar cheese is: Flavor 40, body and texture 30, color 15, finish and boxing 15.

The English scale of points is: Flavor 35, quality 25, texture 15, color 15, make 10.

The New Zealand scale is flavor 45, body 20, closeness 20, color 10, finish 5.

Directions for Cheese Grading. In this state rules are issued by the Wisconsin Department of Agriculture and Markets, State Capitol, Madison, Wis., governing the "grades."

(78B) A First Class American Cheese should have—

Texture, smooth, silky and close boring.

Flavor, fine and nutty, with pleasing acid taste.

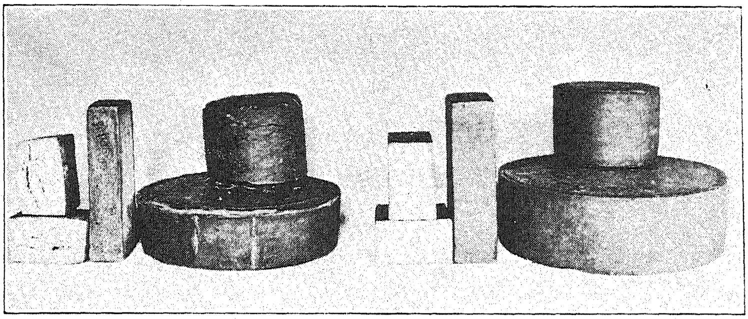
Color, even and slightly translucent.

Finish, a smooth rind covered with a closely fitted bandage and a square edge.

(79) Steps for the Beginner in Judging American Cheese. See that the cheese is in fit condition for scoring as to temperature, age, etc. Cheese in cold storage at temperatures near freezing, or exposed for some time to very low winter temperatures or very warm summer heat, can be better judged in comparison with others if all are placed for 24 hours in a room of moderate temperature, as at about 50-60 degrees F. Very cold cheese feel harder and very warm cheese feel much softer and are difficult to compare under extremes of temperature. Very

young cheese, only a few days old, are curdy or uneven in texture, and it may be difficult to predict with certainty what their quality will be when fully cured.

Cheese change most rapidly when young, and while a rough judgment may generally be passed on green cheese, yet for accurate scoring American cheese should be preferably at least one month old.



Defective workmanship produces cheese of poor appearance.

(80) The Outside Appearance of Cheese and Boxes. Sometimes a cheese may be scored down because poorly packed or a shipment cut in value because of broken boxing which must be replaced, or a shipment refused by the carrier because insecurely packed, as with loose lids. (291)

(80A) Examination for Careful Make Up. It is the maker's fault, when cheese show a wrinkled bandage, a checked or poorly closed rind, are crooked, that is higher on one side than on the other or show a high edge due to loose followers, a dirty or torn bandage, etc., as these are entirely under his control, and can generally be prevented by the maker. The appearance is judged first.

(81) Taking a Trier Sample. Drawing a trier plug should be done carefully so as to get a representative sample of the cheese, not going too close to an old trier hole, or spoiled, moldy, or soft place in the cheese, a cut surface, or the rind. At times, as where several judges are at work, samples can easily be taken from different parts of the same cheese, which is a distinct advantage since cases have been known where a Long Horn cheese, for example, bored at one end scored 5 points or more above a sample taken from the other end, due to mixing of curd or other causes. Too much boring injures sale. Always replace carefully the outer end of the trier plug and seal the opening air tight with cheese, butter or paraffine.

(82) A Full Trier. A perfectly close, compact cheese will draw a solid or "candle" plug, while a cheese so open or loose as to draw only half plug may be scored down on this account.

(83) An Open Cheese. The plug may be of full length, and yet show many small round holes, due to gas forming bacteria from unclean milk, or it may show many mechanical holes, large or small but irregular in shape, due to imperfect closing of the cheese in the press, or partly rounded holes indicating the presence of gas as well as mechanical faults. Mechanical holes may be seen filled with butter fat, due to pressing a greasy curd without first rinsing it. Insufficient pressure or too much acid, or pressing too cold, or a greasy condition may cause loose texture.

(84) Is the Plug Elastic and of Good Color? A trier plug taken from a well made cheese can be bent, sometimes into a half circle, without breaking. If the cheese breaks suddenly, and will not bend, showing it to be brittle and not elastic, this is usually due to too much acid developed while making the cheese, and the high acid quality is likely to be shown also by a dead white, or chalky white, or faded color, as well as an unpleasant acid, or sour taste. Besides bending well, a plug from a good cheese breaks gradually, showing a torn surface with a meaty or fibrous texture. The color should be slightly translucent, like amber, whether cheese color was used or not.

(85) Working and Warming the Cheese in the Hand. To judge how a cheese will please the eater, it is not necessary to chew and swallow it, and the cheese judge's sense of taste would soon weary and fail, if many samples were eaten. Instead of chewing, a portion of the plug perhaps an inch long is kneaded between the thumb and fingers for a few minutes, noting whether (1) it is firm enough, or weak and soft, or too hard, corky or woody, and if

(2) it works down to an even waxy mass or dough, or leaves some lumps which will not work down smooth, and if

(3) it is pasty, wet, sticking to the fingers, indicating a high moisture content, or is too dry, or is waxy, and fine grained, or is mealy and coarse grained, etc.

(86) Flavor Detected by Odor or Taste. Finally, the lump of warmed and kneaded curd is lifted to the nose, and the odor noted, also at times a small portion may be chewed and then rejected from the mouth, and the mouth rinsed after each trial or after a few trials. A bitter flavor usually cannot be detected by the nose, but must be tasted; while almost any other defect in flavor can be observed as well by smelling as by tasting.

Faults in flavor due to too much acid, or due to unclean milk are readily detected. Too much salt or lack of it is occasionally noticed by the taste. Injury due to overheating cheese in the curing room or shipment may occur.

(87) Defects in American Cheese.* A useful exercise for students in cheesemaking is to copy the following list of faults in the note book, and to learn one or more methods by which each fault can be remedied or prevented.

I. Defects in Make-up or Finish.

A. **High Edge.**

Cause. (1) Poorly fitting followers, or hoops too full.
(2) Applying pressure too quickly.
(3) Dressing cheese before sufficient pressure has been applied.

B. **Crooked Cheese.**

Cause. (1) Improperly fitting followers.
(2) Hoops not filled evenly.
(3) Applying pressure too quickly.
(4) Head block crooked.
(5) Hoops do not slide freely in press.

C. **Bandage.** Wrinkled, torn, dirty, too long or short at one end, loose from cheese.

Cause. (1) Carelessness in dressing, handling, boxing, etc.

D. **Checked or Open Rinds.**

Cause. (1) Greasy curds.
(2) The use of hard and impervious press cloths.
(3) Lack of pressure while in the press.
(4) Too rapid drying when first taken from press.
(5) Removing press cloths too long before paraffining.

II. Defects in Texture.

A. **Dry or Corky Textures.** Appear dry and hard and do not mould waxy.

Cause. (1) Lack of butter fat, due to skimming.
(2) Cooking too high or too long, losing moisture.
(3) Setting at too high temperature, losing fat.
(4) Handling curds roughly, losing fat.
(5) Cutting curds too fine.

* See M. Michels in Wis. bulletin 182; also Publow, Cornell bulletin 257. Circ. 157, U. S. Dept. of Agr. office of the secretary.

B. **Acid Textures.** Appear short and mealy, also look faded in color and sour to taste.

Cause. (1) Ripening the milk too much before setting.
(2) The use of too much starter.
(3) Developing too much acid before curd is firm.
(4) Developing too much acid in the whey.
(5) Insufficient stirring when out of the whey.
(6) Too high ratio of moisture to casein in cheese.

C. **Weak Textures.** Weak, wet, soft, too much whey in cheese.

Often made in cold weather to get larger yield. Such curds often mat down very thin.

Cause. (1) Insufficient cook. Too high moisture.
(2) Heating the curd too rapidly, or too early.
(3) Insufficient drainage before matting.
(4) Cutting the curd too coarsely.
(5) Not enough salt.
(6) Rarely due to very rich milk.

D. **Open Textures.** Cheese very soft and full of holes.

Cause. (1) Too little acid developed before salting.
(2) Insufficient pressure while in press.
(3) Too high a temperature of curing room.

E. **Gassy Textures.** Indicated by spongy texture and full of small rounded openings throughout the cheese.

Cause. (1) Produced by bacteria brushed into the milk with dirt from cow's udder while milking.
(2) Use of unclean cans, or a dirty whey tank.
(3) Gassy starters, foul well water, etc.
(4) Too warm curing room.

F. **Greasy Textures.** Indicated by free butter fat between particles of curd which are not cemented together.

Cause. (1) Very rich milk. Milk frozen, or 2 days old.
(2) Setting vat at too high a temperature.
(3) Piling and maturing the curd too long at high temperatures, and not rinsing.

III. Defects in Color

A. **Dead or Faded in Color.** The cause and remedy the same as in acid texture.

B. **Mottled in Color.** Uneven color in the cheese, most noticeable in the case of colored cheese.

Cause. (1) Mixing curds of different colors.
(2) Uneven development of acid on curd.
(3) Uneven cut. Lumps of curd in whey.
(4) Adding a curdy starter without straining.
(5) Adding starter after the milk has been colored.
(6) Making rennet tests before adding color.
(7) Milling too early, into uneven sized pieces, causing uneven salting and curing.

C. **Red color** blotches inside of cured cheese may be caused by use of saltpetre in milk or cheese.

IV. Defects in Flavor

A. **Acid Flavors.** Indicated by a sour smell and taste.

Cause. (1) Ripening the milk too much before setting.
(2) Use of too much starter.
(3) Use of sharp and overripe starter.
(4) Insufficient cook at the time of drawing the whey.
(5) Too high ratio of moisture to casein in cheese.

B. **Lacking Flavor.** Lacking in taste and smell.

Cause. (1) Setting the milk underripe.
(2) Cooking a slow-working curd up too rapidly.
(3) Too much washing of the curd when placed on the racks or after milling.

C. **Fermented Fruit Flavors.** Indicated by a fermented whey or fermented fruit smell and somewhat sickening to the taste.

Cause. (1) Unclean cans in which milk is delivered.
(2) Unclean factory conditions, whey tanks, leaky vats, impure well water, etc.
(3) Added with the starter, or well water.

D. **Bitter Flavors.** Indicated by a bitter taste.

Cause. (1) Aged Milk.
(2) May develop in the starter.
(3) By bacteria brushed from the cow's udder.
(4) Lack of salt.

E. **Weedy or Food Flavors.**

Cause. (1) Cows feeding on weeds.
(2) Feeding strong-scented feed just before or while milking.
(3) Exposing milk in an atmosphere laden with food flavors.

F. **Stable Flavors.** Bad taste and cow-stable smell.

Cause. (1) Uncleanliness in milking.
(2) Keeping the milk in or near a dirty cow-stable.

G. **Unclean or Off Flavors.** Indicated by an unclean smell or taste.

Cause. (1) Often a combination of defects, as
(2) Unclean cans and other utensils coming in contact with the milk.
(3) Unclean milking. Lack of cooling.
(4) Exposing the milk to impure air.
(5) Using impure water in setting the milk or in rinsing the curd.
(6) Using a starter of unclean flavor.
(7) These terms are often used when the judges fail to find a suitable description.

H. **Moldy Condition Inside of Cheese.** Dark color and off flavor in trier plug or cut surface.

Cause. (1) Mixing old curd into cheese in the hoop.
(2) Any openings left in rind after pressing, admitting air to interior of cheese, permitting mold to grow inside.
(3) Trier plug holes not well sealed.

J. **Swiss Cheese Inspection.**

Swiss cheese are examined:
(1) As to a perfect rind, and
(2) As to the number, size and even distribution of "eyes." For this purpose, the "sound" is noted, when snapping the finger against the cheese surfaces, on both sides. The cheese may also be sampled with a trier, either full sized, or using a narrow trier about the size of a lead pencil. In recent years, the use of an X-ray equipment at the warehouse makes the "eyes" and their distribution visible to the inspector.
(3) As to body, flavor, fat and moisture content.

CHAPTER XII.

Planning Factories, Large or Small. Costs

(89) A new factory should be located centrally among the patrons, on a well built road, or crossroads, where good drainage is available, a good water supply can be had, and if convenient on a hill side or sloping land, so that milk, whey, etc., can run by gravity instead of being pumped.

Although gasoline engines or electric motors may be used for power, each factory should have a steam boiler, so as to steam utensils, make starter, and pasteurize whey which is sometimes required by law.

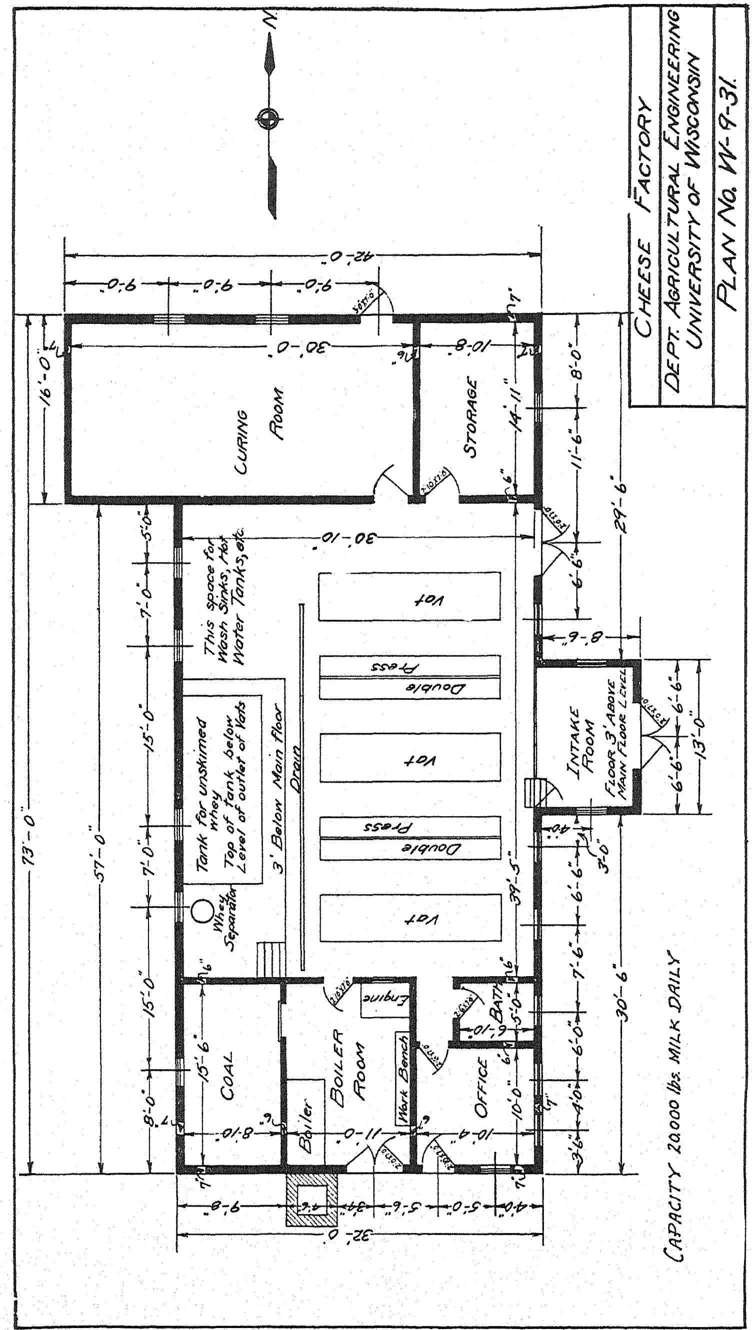
The plan should usually show the curing room on the north or coolest side, and if possible the intake on the east or south side for warmth and light in the morning. The building for American cheese is commonly above ground, but for Swiss, Limburger, brick or other cheese requiring curing before sale in a moist room of moderate, even temperature, the curing room usually extends underground, or into the side of a hill. Maker's living rooms are often built above the factory. The curing room space in American cheese factories is frequently built too small.

The necessary dimensions of a factory are readily figured when the number and size of vats and other equipment, or the amount of milk to be handled is known.

The whey should be skimmed, except at Limburger factories, using a whey storage tank and a separator. Chap. XV.

The whey tank outlet should be in sight of the intake and high enough to run whey by gravity into cans on the patron's wagon. Concrete whey tanks do not last long, unless protected by a special acid-proof surface. The metal or wooden whey tank may be set on wooden or concrete posts out of doors, or over the coal bin, or even in the upper story of the building, but there is danger in this case of whey leaking down over the make vats or curing room, and causing damage and insanitary conditions. A concrete block, 6 by 10 feet, with a slope toward the middle, and a bell drain and tile outlet should be placed under the whey outlet at every factory, so as to catch and remove all spilled whey, buttermilk, washings, etc., and thus entirely prevent the foul smelling mudhole which has been the worst nuisance at factories in the past.

Concrete floors, smooth walls and ceiling which can be washed or painted, thick walls especially around the curing


CHEESE FACTORY
DEPT. AGRICULTURAL ENGINEERING
UNIVERSITY OF WISCONSIN
PLAN No. W-9-31.
CAPACITY 20,000 lbs. MILK DAILY
CURING ROOM
STORAGE
This space for Wash Sinks, Hot Water Tanks, etc.
Tank for unskimmed whey
Top of Tank below Level of outlet of Vats
3' Below Main floor
Drain
Vat
Double Press
Vat
Double Press
Vat
Whey Separator
INTAKE ROOM
FLOOR 3' ABOVE MAIN FLOOR LEVEL
COAL
BOILER ROOM
Boiler
Engine
Work Bench
OFFICE
BATH
N

room, plenty of light and ventilation, and steam heat if possible are important details. The general aim should be to construct and arrange building and equipment so as to give the factory operator every facility for cleanliness and no excuse for lack of it. The operator of the factory in Wisconsin must be licensed, as well as the cheesemaker, and the printed requirements and suggestions for licensed factories as to construction and arrangements should be obtained before building from the Dept of Agric. and Mkts., State Capitol, Madison, Wis.

Factory equipment, or at least the boiler, may be owned by the owner of the building, or the other equipment may be brought in by a cheesemaker who comes to work at the factory.

Bulletins on factory planning, organization, construction or operation can be obtained from the agricultural colleges in several states, as Georgia Bul. 292.

(89A) Water Supply and Sewage Disposal. Pure water supply both at farms and factories is an important factor in the production of fine quality cheese. A dug well at a farm or factory may furnish pure water for many years, and finally become infected with sewage or seepage from near-by barn yards, cesspools, etc., so that it must be replaced by a drilled well going down through rock, and cased with iron pipe, to exclude the sewage with which the soil has become infected.

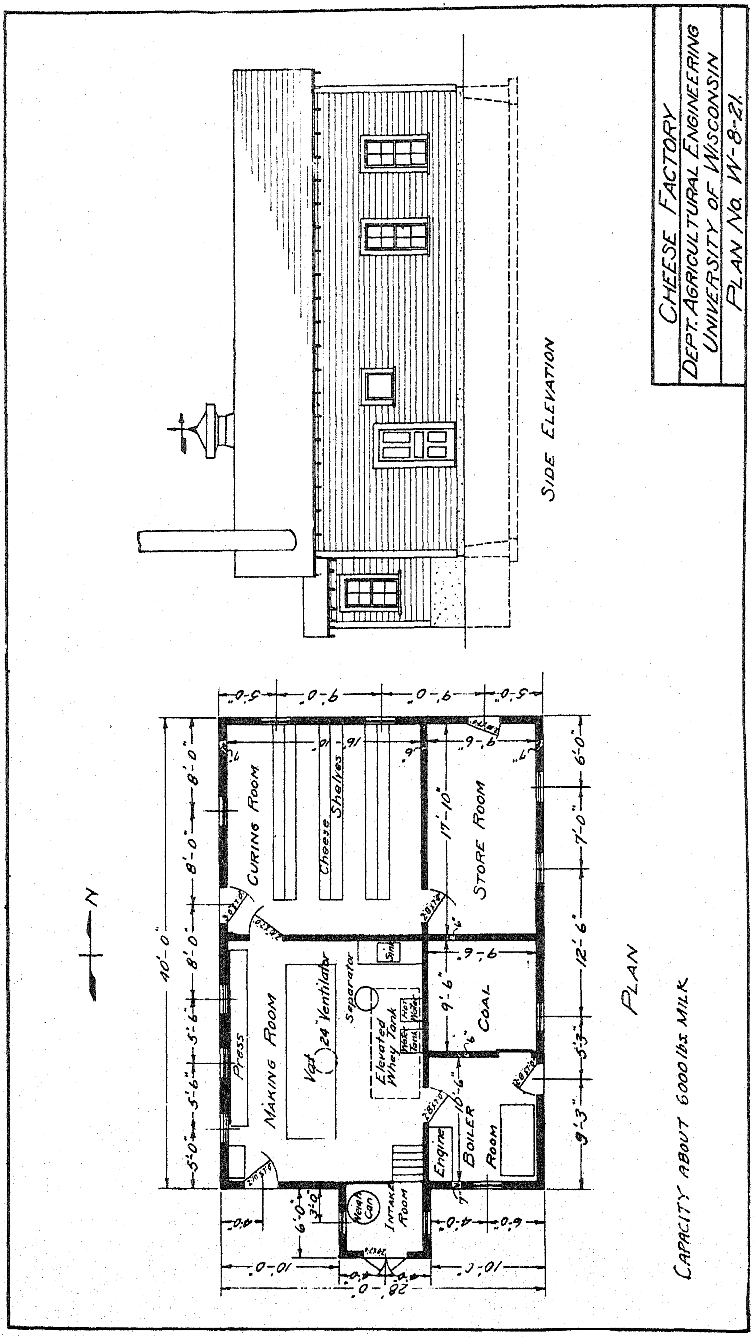
The putrid odors in sewage or manure, or in sewage infected cheese, or in the mud puddle at the whey tank, are produced by a class of bacteria which can live and work in the absence of air and are therefore called "anaerobic."

At a farm house with an indoor sanitary toilet, the small septic tank in the yard serves to hold the solid excreta until they are decomposed and dissolved by action of anaerobic bacteria, so that the dissolved material can run through a drain tile and finally be disposed of.

Cheese factory drainage, containing whey, is apt to develop acidity because of the milk sugar and lactic bacteria present in it. The acidity greatly hinders the growth of the anaerobic bacteria, coli, etc., in the septic tank, so that it is generally advised to keep whey out of such a tank.

The final disposal of the dissolved material from the farm septic tank or from the factory depends either (1) upon running it into a stream or underground, or (2) spreading it over the soil to soak in.

(1) If whey or septic tank effluent is run into a stream, the requirement is that the volume of the stream shall be 30 or 100 times larger than the volume of the waste. In the stream,


CHEESE FACTORY
DEPT. AGRICULTURAL ENGINEERING
UNIVERSITY OF WISCONSIN
PLAN No. W-8-21.
SIDE ELEVATION
PLAN
CAPACITY ABOUT 6000 lbs. MILK
CURING ROOM
Cheese Shelves
STORE ROOM
MAKING ROOM
Press
Vat
24" Ventilator
Separator
Elevated Whey Tank
Sink
COAL
BOILER ROOM
Engine
INTAKE ROOM
Weigh Can
40'-0"
28'-0"
17'-10"
12'-6"
10'-6"
9'-6"
N

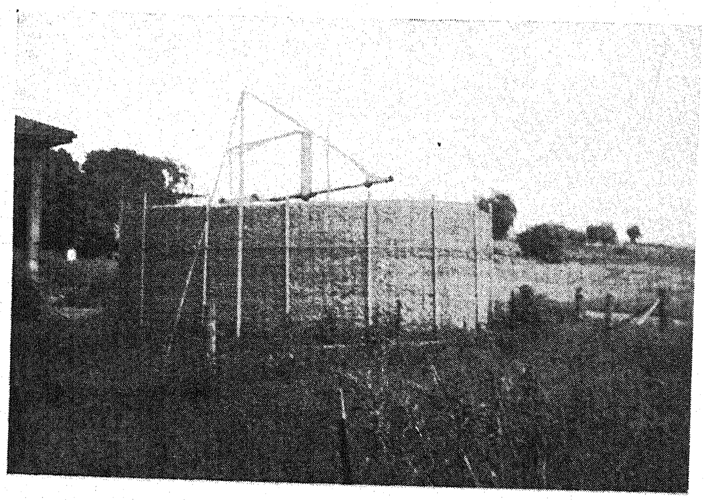
another class of bacteria (aerobic) work on the waste matter, at first, combining it with the air (oxygen) dissolved in the stream water, forming odorless products, but at the same time using up the small amount of dissolved oxygen in the water. As soon as this occurs, the fish in the stream die for lack of (dissolved) air in the water, and the anaerobic bacteria present in the water begin to decompose the sewage and the dead fish causing a foul odor in the stream. The solids from 1 pound of milk may be sufficient to deplete the dissolved oxygen in 3000 gallons of stream water.

(2) For spreading the liquid over a wide, level field, rows of tile are laid near the surface, extending to all parts of the field. The field is divided into two sections, so that half of it may be drying up by evaporation or soaking away, while the other half is being flooded. If a field is kept continually flooded, a puddle or marsh is created, from which putrefactive odors arise. Whey run into a roadside ditch, which remains muddy, also develops the same foul odor. The mud puddle by the whey tank, where whey is spilled daily, soon becomes a nuisance by its odor, due to these anaerobic bacteria in the mud.

If the soil is such that by digging five or ten feet a bed of sand or gravel is reached, the liquid (grease-free) may run into such a pit (cess-pool) to soak away through the sand. If 20 or 30 feet deep, with a sand layer at the bottom, it is called a "dry well," and is walled up and covered to keep out rain water, etc. By this means, no foul odor escapes. (Wis. Circ. 173.) (Farmers' Bul. 1227.)

In building such a dry well or cess-pool, a grease trap should be provided, as the presence of grease in the well is likely to seal up the surface of the sand layer in a year or two, so that the escape of liquid into the sand layer ceases, and the well or cess-pool fills up, and becomes useless.

Biological Filtration Method. This newer method of factory waste disposal depends upon the action of aerobic bacteria in the presence of air upon the liquid wastes, without any foul odor production. This process reduces the "oxygen demand" of the liquid by 90-95%, making it odorless and safe to run into streams containing fish. The equipment includes a holding tank, an intermittent filter, and a settling tank. The filter consists of small cracked stones, with free air circulation throughout the mass. The liquid wastes, applied intermittently, are rapidly oxydized by action of the aerobic bacteria, with which the stone filter surfaces are inoculated. Such an outfit has been in operation at Arthur, Grant county, Wis., and at some other plants. The construction is described in Michigan special bulletin 272, for handling 2000 to 25,000 gallons of wastes per day.



Biological Filtration.

(89B) Boiler Scale Prevention. Water supplies for boiler feed, from deep wells in various parts of the country, contain different kinds and amounts of lime salts, magnesia, iron, sulphates, chlorides, carbonates, etc., dissolved from the rocks below.

In the boiler, these impurities are not converted into steam, but become concentrated in the boiler water, some of them going to form mud, and a part forming a hard boiler scale which adheres tightly to the hot iron surfaces.

Some of the mud and of the minerals that remain soluble may be removed from the boiler by means of the blow-off cocks. The scale is removed by entering the boiler through the manhole and cleaning it thoroughly.

Boiler scale is a poor conductor of heat, so that more fuel is required to get up steam. In a badly scaled boiler, the iron plates are likely to become overheated and may be seriously weakened, and may form a blister, sometimes resulting in an explosion.

The prevention of boiler scale formation is therefore important in any large or small steam plant. For large plants, the water is tested, and suitable chemicals are added to the raw water in tanks. After settling, the soft, clear water is drawn off for use in the boilers. Well waters differ in the treatment each requires, because they vary in the kind and amount of impurities present.

For any cheese factory boiler, a sample of the well water can be tested, and a treatment prescribed such that little or no boiler scale will be formed, but the mineral impurities in the feed water can be drawn out through the blow-off cock.

(90) Large Factories Compared with Small Ones. The farmer's argument in favor of many small factories was the shorter haul for the patrons. The cheesemaker's reasons are that the milk arrives early and promptly, and therefore in better condition than when brought in by long haul on a truck, and maker meets the farmer himself each morning, and can talk to him directly about factory business, cleaner milk, etc. Truck drivers, on the other hand, are more interested in getting a big load of milk to haul, and less in the quality of milk for cheesemaking.

Based on these reasons, it may be argued that a factory may well grow as large as possible, as to milk supply, so long as the patrons or maker do the hauling so that they come together daily, and thus have the advantages of the small factory. Such a factory with 10,000 lbs. milk or more is fortunate. The loss of one or two patrons who will not clean up, can rightly be considered an advantage, and the maker does not hesitate to talk "cleanliness" to his farmers.

With less than 5000 lbs. certain disadvantages may become serious as the milk supply becomes smaller. Based on the weight of cheese sold, the maker's pay at the smallest factories is too small. With only a small milk supply, the maker dare not offend a single patron by criticizing his milk quality or cleanliness, for fear of losing his can of milk.

In recent years, some small fatcories have started milk trucking routes, in order to get a vat full. Very few if any makers will claim that they do not lose money in running a truck. The truck that runs into another factory's territory, reduces the milk supply of that other factory, and usually gives the milk a longer haul.

The larger factory having 20,000 or more lbs. of milk can partly offset the effect of a long haul on milk quality by use of a pasteurizer at the factory, (2) with plenty of milk, it can afford to secure and hold the most skillful and experienced cheesemakers, (3) can buy supplies in larger quantities, and on most favorable terms, (4) with a large output it can attract buyers, and ship in larger lots, and (5) can expect to make cheese at a lower cost per pound, as shown below.

The following table, from the 1916 Year Book of the U. S. Department of Agriculture, illustrates the relative cost of cheese manufacture, and returns to farmers from factories handling large or small quantities of milk, in 1914:

Factory No.	Milk	Yield of cheese for hundred-weight Pounds	Cost per pound for making cheese Cents	From milk per hundred-weight	From butter-fat per pound Cents
1	4,861,981	11.32	1.75	$1.546	38.7
2	4,153,089	11.17	1.75	1.513	37.8
3	4,078,036	11.17	1.75	1.540	38.5
4	2,527,709	11.24	1.75	1.535	38.4
5	2,106,504	11.03	2	1.474	36.9
6	1,931,413	10.92	2	1.461	36.5
7	1,901,107	10.88	2	1.457	36.4
8	1,844,850	11.09	2	1.511	37.8
9	1,720,606	11.21	1.75	1.544	38.1
10	1,595,005	10.95	1.75	1.475	36.9
11	1,262,108	11.09	2	1.402	35.1
12	1,006,872	11.08	2	1.479	37.0
13	947,273	11.05	2.25	1.447	36.2
14	889,548	10.91	2.25	1.403	35.1
15	642,888	11.18	2.50	1.412	35.3
16	611,158	11.35	2.25	1.492	37.3
17	530,580	11.02	2.50	1.397	34.9
18	465,493	11.03	2.50	1.396	34.9
19	126,195	10.55	3	1.291	32.3
Total,	33,202,516	11.12	----	----	----

See also Mis. pub. 42, U. S. Dept. of Agric.

(91) Increasing the Milk Supply. The aim should be kept in mind to increase milk supplies from the near-by farms to the point where 10,000 pounds or more of milk can be hauled by the patrons.

The increasing use of milking machines by careful operators has done much toward overcoming the objection to keeping more cows. Wis. Bul. 173; Stencil Bul. 85; Res. Bul. 3.

An important matter for the average dairy farmer is the improvement of his herd. Cow Testing associations of where there are about 122 in Wisconsin in 1936 and 173 in 1941; and about 978 in the United States in 1936, and 1383 in 1941, are a great help in this work. One competent man or woman, engaged by an association of about 25 farmers to spend one day per month at each farm, weigh and test the milk, and perhaps also weigh the feed used, enables the farmers to pick out with certainty the unprofitable cows to be disposed of, and to know precisely what each cow is doing to make the herd profitable. The best producing cows are bred to superior sires, preferably purebred and tested sires, and the calves are kept to replace the poorest producing cows in the herd. By proper attention to cow testing, breeding and feeding, the milk and fat produced by many herds has been more than doubled and the profits enlarged in yet larger proportion without increasing the number of cows.

A good milk cow is one which has the ability to consume a large amount of feed, and transform it into milk. A less desirable animal might eat the same amount of feed, but transform much of it into body fat, giving little milk.

For cheese factory herds, high producers of low fat per cent milk are most widely preferred. (68S)

Having a good cow, the aim is to feed her all that she can consume, without producing any great increase in her weight. (Dairy Cattle Breeds, Farmers Bul. 1443.) (77D)

(91A) Feeding Cows. Prof. Geo. C. Humphrey of the Wisconsin Agricultural Experiment Station advises that a cow weighing approximately 1,000 lbs. may receive daily 1 pound of grain mixture for every three or four pounds of milk produced, in addition to either (1) 30 pounds of corn silage and 10 pounds of hay, clover or alfalfa preferred, or (2) 30 pounds of roots and 15 pounds of hay, or (3) 8 pounds of dried beet pulp soaked 12 to 24 hours before feeding, or (4) 20 pounds of hay with one or two pounds of oil meal added to her grain. Cows exceeding 1,000 pounds in weight should receive relatively more hay and silage or roots. An important problem for the farmer is to select an economical grain mixture from those available in the market, and to grow alfalfa, put up silage, etc., on the farm and thus reduce the cash outlay for purchased feeds. Valuable suggestions on cow testing, breeding, and feeding which the factory man is able to give the farmer will be returned to the factory in increased milk supply and profits. U. S. Dept. Agr. Dept. Circ. 368. S. Dak. Bul. 231. Farmer's Bul. 1723.

(91B) Feeding Whey to Pigs and Calves.

Pigs. Skimmed whey is worth about one-half as much per 100 lbs. as skim milk. This means that 100 lbs. of skimmed whey is worth about one-fourth as much as a bushel of corn. Unskimmed whey from American or cheddar cheese factories, which contains about 0.3 per cent fat, will be worth a trifle more, and unskimmed whey from Swiss factories, which may contain 0.8 to 1.0 per cent fat, will have a materially higher value than skimmed whey. W. Va. Circ. 74.

Whey from sulphuric acid casein manufacture has been fed to hogs without injury

Calves. As an example of the results which may be secured from whey, a trial at the Wisconsin Station by Morrison, Humphrey, and Hulce may be mentioned. At 3 weeks of age, 8 calves were gradually changed from whole milk to separated whey, 10 days being taken for the change. In addition the

calves were fed a protein-rich concentrate mixture, consisting of 30 parts ground corn, 30 parts standard middlings and 40 parts of linseed meal, with legume hay for roughage. The allowance of whey was gradually increased to 14 lbs. per head daily at 6 weeks of age. Those calves gained on the average 1.48 lbs. per head daily, during the trial which lasted 6 months, and were vigorous and thrifty. Calves fed a liberal allowance of skim milk made slightly larger gains, 1.68 lbs. per head daily. Satisfactory results have also been secured with whey at the Kansas Station.

Whey should always be pasteurized at the factory to prevent the spread of disease. Whey soured in clean containers is as valuable as sweet whey, unless the acidity causes scours, as in calves. (110)

(92) Modern Factory Improvements. The successful cheese factory looks attractive. Outside paint, neat yard, gravel drives, and a road-side sign suggest prosperity. Entire absence of odors from spilled whey is necessary.

Waterproof paint on the make room ceiling and walls to prevent rotting and mold growth, clean cloth covers on vats, fly screens or sprays or electric fly killers, painted vats, pipes, agitators, a roomy intake, can washer, ventilators, plenty of light and air are worth their cost. Automatic coal stokers, and automatic water level control on the boiler are used at some factories.

Concrete floors should be laid in one piece, not with a thin surface layer on top to crack off. As gutters wear out first, a slot should be left in the floor so that the gutter can be built in afterward, and thus can be dug out easily and replaced when necessary.

Steam table heat for starter milk gives best results. The modern curing room has cork insulated walls, floor and ceiling, no windows, with a small refrigerator unit to cool the air and keep it dry.

With 10,000 lbs. milk or more, a flash pasteurizer for use in summer or all the year is a great help, especially where milk is hauled several hours on a truck. Today, the successful maker is planning for the necessary improvements at his factory.

(92A) Factory Equipment and Costs. The following estimates of equipment, supplies and costs are reprinted by permission from the Annual Report of the Wisconsin Cheese Makers Convention, prepared and revised by Mr. E. C. Damrow, Fond du Lac, and may serve to illustrate the method and items of figuring costs at any factory.

Equipment for an Average Wisconsin Cheese Factory Using Electric Current

6,000 lbs. Milk Daily (in flush)
1,000,000 lbs. Milk Annually — 100,000 lbs. Cheese Annually

MAKING DAISY CHEESE

		Cost	Years in Use	Dep. in Year
1	7,000 lb. 20 ga. Vat	$270.00	6	$45.00
1	2 L. S. Cheese Press	172.00	12	14.33
1	12 H. P. Boiler	527.00	15	35.13
30	Daisy Hoops @ $3.75	112.50	12	9.37
1	Damrow Elec. Forking Agitator	252.75	10	25.27
1	Set Hoisting Cranes & Irons	10.50	15	.70
1	80 gal. Weighing Can & Opener	30.50	15	2.03
1	Weighing Can Strainer	13.00	10	1.30
1	20 gal. Starter Can, Elec.	120.00	8	15.00
1	700 lb. Fairbanks Scale	59.40	10	5.94
1	100 lb. Howe Scale	23.00	10	2.30
1	Set 8″ Curd Knives, ¼″ cut large	12.00	10	1.20
1	Curd Mill, Electric	54.50	10	5.45
1	7′ Cond. Head and Spout	7.00	7	1.00
1	Strainer Curd Pail	1.75	4	.44
1	Small Tin Tank 13x26x10″	6.50	5	1.30
1	Galv. Wash Sink, Round Bottom	18.00	4	4.50
1	18′ Vat Cover	7.80	3	2.60
1	Curd Fork	2.50	3	.83
1	5700 lb. Baltic Separator, No. 4 Motor Drive	889.50	12	74.13
1	6,000 lb. Tin Whey Tank	142.00	10	14.20
1	D S K Vik. Pump	125.95	5	25.19
1	D K Vik. Pump	128.95	5	25.79
	Sanitary Fittings	45.00	10	4.50
1	7,875 lb. Round Redwood Tank 31½ bbl.	49.86	12	4.15
1	6″ Wood Whey Pump	12.00	3	4.00
1	Adjustable Conductor Head and Spout	6.50	2	3.25
4	dozen ½ pt. Sample Bottles with numbers @ $1.90	7.60	3	2.53
1	25 bottle Babcock Tester, Electric	58.00	12	4.83
1	Test Bottle Bath, 24 bot.	4.00	5	.80
1	Divider	.65	5	.13
1	Marschall Rennet Test	2.50	10	.25
1	Marschall Acid Test	5.00	3	1.66
1	Vacuum Sediment Tester	10.00	8	1.25
1	20 Sample Moisture Oven, Electric	25.00	10	2.50
1	No. 1715 Torsion Balance	39.00	10	3.90
1	Daisy Curd Scoop	2.00	5	.40
1	Cheese Knife	1.00	10	.10
1	4 Quart Dipper	2.50	2	1.25
1	Cheese Trier	5.50	2	2.75
1	Pay and Record Book, 50 Patrons	3.00	4	.75
1	2x2x4′ Galv. Water Tank	6.30	6	1.05
	Steam Pipe and Fittings, Valves, etc., and Labor	60.00	16	3.75
	Transmission, including 24′ 1¼″ Shaft @ 34c $ 8.16 1 Shaft Coupling 2.75 4 1¼″ Hangers 14″ drop $4.55 18.20 2 24x6 Wood Pulleys 14.85 2 12x6 Wood Pulleys 7.35 1 4x4 Wood Pulley 2.18	53.49	16	3.34
	Estimate for 1937	$3,386.00		$360.14
	Revised estimate for 1940	3,830.50		388.85

For Southern Factory

Pasteurization equipment $1,500.00
Refrigeration $2,000.00
Boiler required when pasteurizing 20 H. P.

Equipment for a Large Wisconsin Cheese Factory Using Electric Current

18,000 lbs. Milk Daily (in flush)

3,000,000 lbs. Milk Annually — 300,000 lbs. Cheese Annually

MAKING DAISY AND LONGHORN CHEESE

			Cost	Years in Use	Dep. in Year
2	10,000 lbs. 20 ga. Vats	$328.00	$656.00	6	$109.33
2	2 LS Presses 20′	221.00	442.00	12	36.83
1	20 H. P. Boiler		666.00	15	44.40
	Two Sets of Hoops				
90	Daisy Hoops	3.75	337.50	12	28.13
96	Longhorn Hoops	3.70	355.20	12	29.60
2	Damrow Electric Forking Agitators	262.75	525.50	10	52.55
1	Hoisting Crane and Irons		10.50	15	.70
1	100 Gal. Weigh. Can and Opener		35.50	15	2.37
1	Weighing Can Strainer		15.00	10	1.50
1	1,000 lb. Fairbanks Scale 7 bm.		76.50	10	7.65
1	200 lb. Howe Scale		32.00	10	3.20
1	50 gal. Start. Can Motor Drive		175.00	8	21.88
1	Set Curd Knives ¼″ Cut Large		45.00	10	4.50
1	Curd Mill, Electric		54.50	10	5.45
1	7′ Cond. Heads and Spouts	7.00	14.00	10	1.40
2	20′ Vat Covers	9.00	18.00	3	6.00
2	Strainer Curd Pails	1.75	3.50	4	.87
2	Sm. Tin Tanks 20x27x13″	9.50	19.00	5	3.80
2	Curd Forks	2.50	5.00	8	.63
1	8,500 lb. Baltic Separ. No. 6 Motor Drive		953.60	12	79.47
1	11,500 lbs. 20 ga. Round Bottom Whey Tank		243.00	10	24.30
1	D S L Vik. Pump		166.25	5	33.25
1	D K Vik. Pump		128.95	5	25.79
	Sanitary Fittings		60.00	10	6.00
1	20,000 lbs. Round Redwood Whey Tank, 80 bl.		130.50	12	10.88
1	7″ Wood Whey Pump		15.00	3	5.00
1	Adj. Whey Cond. Spout		6.50	2	3.25
1	36 bot. Babcock Test., elec.		74.75	12	6.23
8	Doz. ½ pt. Sample Bottles with Nos. and Chain	1.90	15.20	3	5.06
1	36 Bot. Test Bottle Bath		5.25	5	1.05
1	Gal. Wash Sink R'nd Bot.		18.00	4	4.50
1	Cheese Knife		1.00	10	.10
1	Speed Knife		1.50	8	.19
2	L. H. Scoops, $2.00 and $3.25		5.25	10	.52
2	Daisy Scoops, $2.00 and $3.25		5.25	10	.53
2	4 qt. Dippers 19″ handle	2.60	5.20	8	.65
1	Cheese Trier		5.50	20	.27
1	Divider		.65	5	.13
1	Marschall Rennet Test		2.50	10	.25
1	Marschall Acid Test		5.00	3	1.67
1	Vacuum Sediment Test.		10.00	8	1.25
1	Electric Moisture Oven		20.00	10	2.00
1	No. 1715 Torsion Balance		39.00	10	3.90
1	Pay and Record Book		3.50	2	1.75
1	2x2x4 Water Tank		6.30	6	1.05
	Steam Pipes, Fittings, Valves, etc. and Labor		150.00	16	9.37
	Transmission, including 30′ 1½″ Shafting, 48c	14.40			
	4 1½″ Hangers 14″ drop, $5.50 each	22.00			
	1 Shaft Coupling	3.00	53.75	16	3.36
	2 14x8 Wood Pulleys	10.00			
	2 4x4 Wood Pulleys	4.35			
	4 Double Deck L. H. Truck 80 Ch., $30.00		120.00	10	12.00
	Estimate for 1937		$5,737.10		$604.56
	Revised estimate for 1940		6,181.06		636.39

For Southern Factory
Pasteurization equipment $1,800.00
Refrigeration equipment $2,500.00
Can Washer $1,000.00 to $3,600.00

A 40 H. P. Boiler is required when pasteurizing and can washing.

Supplies for an Average Factory using electric current, and handling 6,000 lbs. milk daily in the flush, or 1,000,000 lbs. milk annually, are estimated to include the following items: 32 gals. rennet, 8 gals. color, 9 barrels salt, 5 gals. acid, cleaning powder, brushes, oil for engine and separator, glassware and breakage, retinning hoops, repairs, 50 tons coal, stationery and milk books, starters, neutralizer, and miscellaneous supplies.

Fixed expenses include depreciation on buildings and equipment, interest on investment, insurance on building and equipment, taxes, and electricity.

Variable supplies may be estimated about as follows:

	Single Daisy	Twins	Long Horn
Bandages	5,000	3,125	7,690
Circles	10,000	6,250	15,380
Press cloths	500	500	1,000
Boxes	5,000	1,563	1,923
Scale boards	10 bundles	3¼	4

Supplies for a Large Factory using electric current, and handling 18,000 lbs. milk daily in the flush, or 3,000,000 lbs. milk annually, are estimated to include the following items: 96 gals. rennet, 24 gals. color, 27 barrels salt, 10 gals. acid, cleaning powder, brushes, oil for engine and separator, glassware and breakage, retinning hoops, repairs, 80 tons coal, starters, neutralizer, stationery and milk books, and miscellaneous supplies.

Fixed expenses include depreciation on buildings and equipment, interest on investment, insurance on building and equipment, electricity, and taxes.

Variable supplies may be estimated about as follows:

	Single Daisy	Twins	Long Horns
Bandages	15,000	9,380	23,080
Circles	30,000	18,760	46,160
Press cloths	1,500	1,500	3,000
Boxes	15,000	4,690	5,770
Scale boards	30 bundles	9½	24

(93) Figure Costs at Each Factory. As long as makers continue to own factories and buy supplies for making, they should know the costs accurately in order to set a fair price for making. When farmers own factories and equipment and buy the supplies, the maker's 'pay' for labor only is easy to estimate.

The cost of making cheese, when correctly figured, is often found to be larger than the farmer or cheesemaker had sup-

posed. In consequence, the maker's income for the year, after paying the factory expenses, may be smaller than he had anticipated. Too low an estimate of the cost of making cheese may occur either:

(1) because the costs were guessed at and not accurately calculated, or

(2) because of certain common errors in factory methods of figuring, leaving out important items.

(93A) Why Factory Costs Differ. In the absence of exact figures, the maker at a small, one man factory is likely to assume that he can make a pound of cheese as cheaply as it can be done at a neighboring factory, where several men are employed to handle a larger milk supply (90).

Experience in different lines of manufacture shows, on the contrary, that from nearly every standpoint the large factory may have advantages over the small one, whether the cost of building and equipment be considered, or the cost of supplies, labor, materials, or other factors in the business.

A few dairy farmers often wish to start such a factory at the nearest crossroads, because of the shorter haul for them. It is evident, however, that the price to be paid per pound for making cheese at the small factory may be larger than at the more distant, large factory, and the farmer should be entirely willing to pay the slightly higher price asked by the maker at the small factory.

Farmers are learning better every year how to keep farm records and accounts, so that costs can be accurately figured, and in coming years every cheesemaker will be expected to show his patrons accurate cost records, since these afford the best possible basis for both to agree on the price to be paid for making cheese at that factory.

Errors and Omissions in Figuring Costs. A common oversight is to omit from the list of costs the proper charges for depreciation and interest on the investment in buildings, equipment and land, the maker supposing these sums to be insignificant. The depreciation of the building and equipment never ceases. The investment should earn interest for every day in the year, although the factory may be closed part of the time.

A second item often overlooked is the cost of annual repairs; and unless all records and bills of the year's business are carefully saved throughout the year, several important items are likely to be forgotten and omitted.

A complete and accurate record of this year's earnings and expenses affords the only basis for knowing the profit or loss, and for making plans for next year.

(93B) Examples of Variations in Makers' Labor Income.* 18 factory reports have been chosen to serve as an illustration of the necessity for a method of accurately figuring costs. At nine of these factories (Group A), the average labor income of the maker was $2069, but at the other nine (Group B) it averaged $237. At the Group A factories this averaged 1.01 cent per pound of cheese, but only .22 cent at the Group B factories. Table I.

Not any of the Group B factorymen had figured correctly their total expenses. Having omitted several important items, they had then charged too little for making cheese, and when the total expense charges were subtracted from their incomes, they were greatly surprised to find out how little money was left, as the "labor income" for the year.

The detailed figures for these factories are shown in Table I.

TABLE I.—LABOR INCOME AND CHEESE OUTPUT AT 18 LARGE AND SMALL FACTORIES IN 1918.

GROUP A			GROUP B		
Factory number	Annual labor income	Average daily output (pounds)	Factory number	Annual labor income	Average daily output (pounds)
51	$1621	827	6	$ 82	427
9	1813	740	1	331	365
28	2089	564	7	444	324
54	1383	561	11	531	301
34	1748	543	15	652	284
53	3246	541	31	494	274
50	3472	541	23	704	271
17	1621	361	26	Loss 864	248
18	1631	375	45	Loss 243	195
Average	$2069	562	Average	$237	298
Average 1.01c per pound of cheese			Average .22c per pound of cheese		

A maker's labor income is the amount of money he has left for himself out of his total receipts at the end of the year after paying all expenses and charges including supplies, repairs, help, depreciation and interest on his investment in factory equipment, etc. Labor income is the maker's pay for his own services.

(93C) Income on Real Estate Investments. In many cases, the amount of money invested in a small factory building and land, and the annual charges for interest, repairs and depreciation are much larger in proportion to the amount of cheese made than at other factories having a larger milk supply. This fact is illustrated by the 18 factories in these two groups.

* From Wisconsin Bulletin 321 by J. L. Sammis and O. A. Juve.

TABLE II.—REAL ESTATE INVESTMENTS AT LARGE AND SMALL CHEESE FACTORIES IN 1918.

GROUP A			GROUP B		
Factory number	Investment in building and land	Interest, depreciation, and repairs for 1918	Factory number	Investment in building and land	Interest, depreciation, and repairs for 1918
6	$5400	$582	51	$4900	$644
1	6100	970	9	3000	467
7	3100	405	28	2675	270
11	2600	350	54	3630	365
15	3075	380	34	5000	607
31	4575	545	53	----	---
23	2700	408	50	4400	414
26	3800	385	17	----	---
45	----	----	18	5050	590
Average	$3920	$503	Average	$4094	$480
Cost per pound of cheese $0.00442			Cost per pound of cheese $0.00221		

The real estate charge for making a pound of cheese at the Group B factories is about double that at the Group A factories.

(93D) Small Plants Fail to Get Full Use of Equipment. It is obvious that a factory must have a vat and press and other equipment whether the vat is full or only half full of milk every day. Therefore, the charges on equipment for each pound of cheese made are likely to be larger at the factories with the smaller milk supplies.

The investment in equipment and the annual charges for interest, depreciation and repairs on equipment at the factories in Groups A and B, for 1918, are shown in Table III.

TABLE III.—EQUIPMENT INVESTMENTS AT LARGE AND SMALL CHEESE FACTORIES IN 1918.

GROUP A			GROUP B		
Factory number	Equipment investment	Interest, depreciation, and repairs for 1918	Factory number	Equipment investment	Interest, depreciation, and repairs for 1918
51	$3275	$950	6	$3080	$559
9	2084	487	1	2052	425
28	1400	---	7	1600	424
54	2766	517	11	1906	641
34	2450	494	15	2217	493
53	2170	475	31	2102	430
50	2140	356	23	670	165
17	1659	477	26	1443	354
18	1395	363	45	1400	368
Average	$2150	$515	Average	$1830	$409
Cost per pound of cheese $0.00205			Cost per pound of cheese $0.00347		

(93E) Larger Factories Buy Supplies on Better Terms. The expense per pound of cheese for supplies, taxes and insurance, is likely to be smaller at a large factory than at a small one. The larger factory is able to buy supplies, such as boxes, in larger lots, at lower prices and on better terms, and to get credit from the bank in order to discount bills.

Every time a boiler is fired and afterward allowed to cool, certain amounts of heat and fuel are wasted. Where a boiler must be heated up to handle a small amount of milk, this loss of fuel is relatively more important than at a factory with a larger milk supply.

TABLE IV.—SUPPLIES, HELP, TAXES, INSURANCE, OFFICE SUPPLIES IN 1918.

GROUP A		GROUP B	
Factory number	Cost in 1918	Factory number	Cost in 1918
51	$4575.89	6	$2500.66
9	4208.68	1	2571.20
28	2220.34	7	1522.95
54	2988.69	11	1157.70
34	2446.75	15	1675.74
53	2798.50	31	1109.50
50	1479.50	23	903.67
17	1283.98	26	1218.30
18	1326.00	45	1238.80
Average	$2592.00	Average	$1544.00
Cost per pound of cheese 1.26c		Cost per pound of cheese 1.34c	

The costs of taxes, insurance on the building, telephone, etc., are the same in amount whether much or little cheese is made, and are therefore more expensive for each pound of cheese made at the small factory.

The cost of certain supplies, such as bandages, boxes, and rennet, is exactly proportional to the amount of cheese made, except as they may be bought cheaper in larger lots. The cost of helper's labor varies.

The cost of these items (Table IV) averages about ten per cent higher for a pound of cheese at the smaller factories.

Adding costs listed in Tables II, III, and IV, gives an idea of possible differences in cost of making cheese in large and small factories.

It is interesting to note that the cost of supplies, help, taxes, etc., per pound of cheese, varies between large and small factories less than does either the labor charge, or the interest and depreciation on factory and equipment. Yet the cost of supplies is the item given most attention by many makers who do not realize the importance of the other items.

SUMMARY OF CHEESEMAKING COSTS AT 18 FACTORIES IN 1918

	GROUP A	GROUP B
	Cost per pound of cheese, cents	Cost per pound of cheese, cents
Buildings and land charges	.221	.442
Equipment charge	.205	.347
Supplies, help, taxes, etc.	1.26	1.34
Makers' pay at $2000	1.00	1.75
Totals	2.686	3,879

To find out exactly what it costs to run your cheese factory for a year may require some little attention and work, but it is worth while to get the correct figures.

In some localities, there may be good reasons for combining the milk supply of two, or even more, small struggling factories, but when carried too far the increased expenses of hauling, and proper supervision may eat up the savings in manufacturing.

CHAPTER XIII.

Cheese Factory Management and Ownership

(94) Division of Labor and Responsibility. The important items in factory management, after the building is erected and equipped, include the following:

(1) Hiring and paying the cheesemaker.

(2) Buying and paying for supplies.

(3) Weighing and testing milk.

(4) Making the cheese of standard quality so as to bring the ruling market price. Moisture and fat testing.

(5) Weighing and billing the correct weight of cheese to the buyer.

(6) Receiving the buyer's payment for cheese and distributing the money according to the plan adopted, figuring payments, statements, etc.

(7) Auditing the accounts.

(8) Economizing in all helpful ways, etc.

(9) Planning improvement for tomorrow.

The aim should be to treat all parties fairly, and also convince them that they are being treated fairly, so that they will continue to patronize the factory and bring in more business. Univ. of Texas, Pub. 4037 (1940).

(94A) Systems of Factory Management. The Private Factory. In a new dairy region, the coming of a cheesemaker who knows how to plan, build, equip and operate a factory is a great advantage to the farmers. The patrons are likely to recognize the maker's leadership and to leave the entire factory operation to him, at the start. In a word, the patrons bring in their milk daily and receive a check once a month, while the cheesemaker does the rest. Under these conditions, the maker is paid not only for making cheese, but also for knowing more about the business than the patrons, who are only beginning to learn. The maker in this case may do, or neglect to do, several things which will serve to confirm the patrons' confidence in him. Among these are (1) explaining the cheese business, so far as the patrons are interested and not making a mystery out of it, (2) furnishing a statement with the pay check which meets the patron's ideas as what a statement should show, (3) providing for an audit of accounts, and in other ways acting so as to retain the patron's good will and confidence. As time passes, the patrons learn more and more about factory management and may come to the point where they wish to pay the maker only for the

work of making cheese, but nothing for rental of the factory which he owns, while the figuring of payments and other parts of the work are done by one of the patrons, elected for this purpose. Under these conditions, the maker cannot expect to earn as much as formerly, and often wishes that he no longer owned the factory, but was free to change his location. On this account, young cheesemakers often are advised not to buy or build factories at their own expense, but to invest their earnings in other ways, such as life insurance or approved farm mortgages, etc.

(94B) The Farmers' Factory. At the other end of the scale is found the factory owned and managed entirely by farmers, where the cheesemaker is paid either by the pound or by the month, for his labor only (items 3, 4, 5 above), or paid by the pound of cheese at a fixed rate for which he furnishes both labor and supplies (items 2, 3, 4, 5, above), while the patrons do the rest. Swiss cheesemakers are paid about 12 or 14 cents on each dollar received from the sale of cheese and cream, if they furnish equipment, or about 10 or 12 cents if they furnish only labor and supplies.

At many American factories making cheddar cheese, the cheese maker furnishing labor and supplies is paid 1½ cents per pound of cheese sold, plus one-half of the whey cream sales money, for making cheddars or flats or daisies, or 2 cents per pound plus one half of the whey cream sales money, for making Long horns or smaller shapes of cheese.

(94C) Other Ways of Operating a Factory. The factory building may be owned by a group of farmers, and run by a factory manager, who in some cases pays a rental of perhaps $100 a year, and in other cases charges the farmers $100 a year or more for his services as manager. The cheesemaking labor and supplies are paid for by the manager, who may also sell the cheese, and pay the patrons monthly by check, with or without a complete statement as to business details.

(95) Partnership or Corporation. In any partnership, any one member of the firm can be held responsible for all the debts of the business. By incorporation, this is avoided.

(96) Cooperative Factory Management in Wisconsin. In the early years, the term "cooperative" was applied to a factory simply because a number of patrons brought their milk, while the maker owned factory and equipment. Later, the meaning of the word was extended to cover any or all of the items, ownership of the building, ownership of equipment, ownership of the cheese until it was sold and paid for, factory management

and finally also to cooperative marketing of cheese from several factories, as undertaken first by the Wisconsin Cheese Producers Federation.

(98) Figuring and Auditing. At a small country factory, where the amount of figuring required is not large, it may be done by the secretary. Sometimes the figuring is done by one of the patrons, or a near-by school teacher, or other party who is paid 10 or 15 cents per patron per month for doing the work. In many cases, the figuring of payments is done, free of charge, at the bank where the factory deposits are kept. (Chap. XVI).

Auditing is done to prevent mistakes. In any case, the person who does the figuring should go over it a second time to make sure that no errors have occurred. At some factories, the monthly figures are gone over by a second person, appointed as auditor, before the checks are sent to the patrons.

(99) Test Committee. A committee of patrons, frequently changed, whose duty it is to be present when the maker tests milk samples for fat, should be asked for, whenever there is any doubt of the correctness of tests. Patrons thus become acquainted with the fat test, and later may be led to take up cow testing.

(100) Economy at a Factory. To avoid unnecessary wastes, and maintain the factory and equipment in good condition is a part of the work of the conscientious maker, but care should be used in planning and erecting a factory to see that the convenient and proper arrangement of rooms and equipment permits the maker to do his work without waste of time, or labor. Fire insurance is good economy, and fire prevention methods should receive attention.

Waste of heat and fuel can be avoided by covering boiler and pipes with good insulation or pipe covering. Exhaust steam can be used for heating water. Waste of lubricating oil, gasoline, soap, washing powder, tubs or boxes used as kindling wood, paper or bandages through storage in damp places, waste of time in starting work because of lack of rules governing the time of milk delivery, unnecessary lifting of milk cans, carrying of cheese or hoops, pumping of whey, all of these can be avoided by giving attention to the matter at the proper time in planning, building, or operating the factory.

(100A) Factory Statement. The form of factory statement used upon the printed envelope should be such as to give the patrons all essential information from which they may figure their own payment if desired, or see how it was figured.

When a maker, disregarding the patron's wishes, hands each one a statement, containing only two or three items, such as the following:

Your weight of milk	5,898	lbs.
Your test	3.5	%
Amount due you	$114.57	

it is not surprising if the patrons become dissatisfied, and wish for a change. It is always to the maker's advantage, at a private or a cooperative factory, to keep the patrons satisfied, and since most factories give a more or less complete statement each month, every maker should expect to do so. The Marketing Department, State Capitol, Madison, Wis., issued a form of statement, given on the following page, which covers all possible items, but most factory statements are much shorter.

Factory ______________________ P. O. ______________________

STATEMENT for Month of ______________________ 19____

STATEMENT OF RECEIPTS AND DISBURSEMENTS

		Receipts	Disbursements
A.	Received from cheese sales	$	
B.	Received from whey cream sales		
C.	Other receipts		
D.	Add (A + B + C)		
E.	Underpayment, last statement (add)		
	Overpayment, last statement (subtract)		
F.	Total Receipts		
G.	Paid for making cheese		$
H.	Other cash expenses. Whey cream(portion)		
	Salaries, fees, etc.		
I.	Total cash expenses (G + H)		
J.	Paid Patrons		
	Add (I + J)		
K.	Underpayment (add)		
	Overpayment (subtract)		
L.	Total Disbursements (should balance with F)		

FACTORY REPORT

M. Pounds milk (milk sheet)		
N. Pounds butterfat (patron's total)		
O. General average test (N ÷ M)		
P. Pounds cheese (styles)		
Horns		
Daisies		
Total pounds		
Q. Yield-lbs. cheese per 100 lbs. milk (P ÷ M)		
R. Pounds cheese per lb. fat (P ÷ N) or (Q ÷ O)		
S. Price per pound cheese (A ÷ P) average		
T. Price per pound fat (J ÷ N) net		
U. Price per 100 pounds (3.5%) milk (3.5 × T) net		
V. Value whey cream per 100 lbs. milk (B ÷ M)		
W. Expense per pound cheese (I ÷ P)		

PATRON'S ACCOUNT

Name

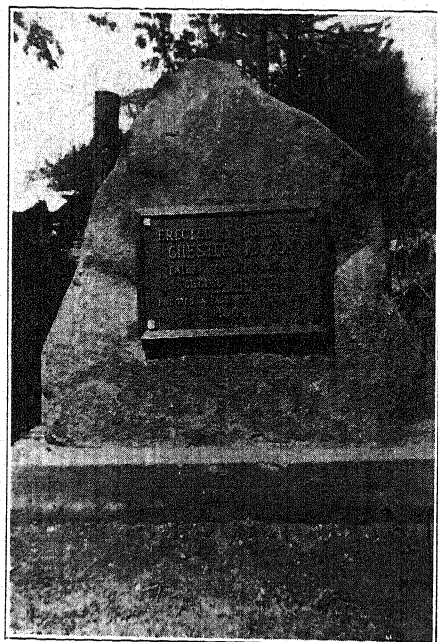
X. Pounds milk		
Y. Per cent fat in the milk		
Z. Pounds fat (X × Y)		
aa. Due patron (Z × T)		
bb. Cheese withdrawn ______ lbs. @ ______		
cc. Butter withdrawn ______ lbs. @ ______		
dd. Cash advanced		
ee. Total debits		
ff. Cash for balance (aa - ee)		

From Wisconsin Circular No. 233.

CHAPTER XIV.

Early History, Cheese Selling and Cheese Boards

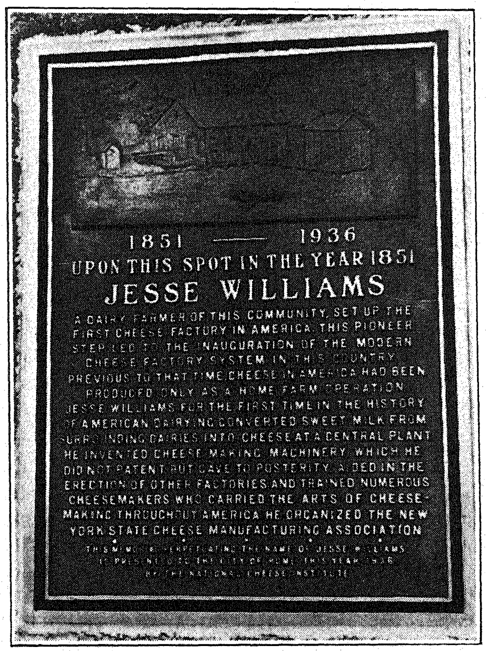
(101) Early History. From about 1837 cheese was made in Wisconsin on farms, and swapped with neighbors for other needed articles. The cooperative factory idea was exemplified by J. G. Pickett who took in the milk from 30 cows (6 patrons) beginning June 1, 1841, at his place in Jefferson Co., Wisconsin. (1878 Wis. State Dairymen's Rept.) (See also W. F. Hubert. 1924 Ann. Rept. Wis Cheese Makers' Assn., pp. 49, 64, 65.)



J. L. Smith of Sheboygan Co., shipped cheese to Chicago in 1858. In 1859 J. V. Robbins of Dane Co., made cheese from 120 cows on his farm

Among other notable pioneer cheesemakers in Wisconsin was Chester Hazen, who in 1864 built the first Wisconsin cheese factory at Ladoga, Fond du Lac county, now marked with a tablet.

Rapid spread of the cooperative factory plan began in 1851 at the factory of Jesse Williams of Oneida county, New York. Harvey Farrington of Herkimer, N. Y., started a cooperative factory in Canada in 1863. About 1867, Robt. McAdam introduced the cheddar (matting and milling) process from England, to replace the old granular process.



A tablet, placed by the Green County (Wis.) Historical society in 1939, on the Alvin F. Ott Farm, New Glarus township, marks the spot where the first Limburger cheese factory in Wisconsin was founded by Nikolaus Gerber, in 1868.

Some other steps in the growth of the cheese industry in Wisconsin are the arrival of the first Swiss cheesemakers colony at New Glarus in 1845, the organization of the Wisconsin Dairymen's Association in 1872, and through the efforts of Governor Hoard the first refrigerator car service in Wisconsin in 1873, the invention of the rennet test about 1885, the establishment of the Dairy and Food Commission in 1889, the invention of the Babcock test and organization of the Wisconsin Dairy School in 1890, organization of the Wisconsin Cheese Makers' Assn. in 1893, passage of the filled cheese and skimmed cheese laws in 1885. Other important steps are the cold curing of cheese begun in 1895, the curd test invented in 1898, the Wisconsin Butter-

makers' Assn. formed in 1901, the moisture oven test in 1907, the sediment test introduced from Europe by Farrington in 1910, the first pasteurized milk American cheese making on a commercial scale in 1913, the cheesemaker's license law passed in 1916, the moisture law passed for American cheese in 1916, the whey butter label law passed in 1917 but later repealed because no chemical test could distinguish any difference between the fat in whey butter, whey cream and cheese on the one hand, and the fat in milk, cream, and creamery butter on the other. The state Marketing Division, established in 1919, issued regulations as to fractional weights in 1920, a three day holding order and a cheese grading system in 1922, and relating to fraudulent statements in 1923, and cheese grading plans later. Swiss cheese milk standardization was declared lawful in 1927, by a decision of the Wisconsin Supreme Court.

A law prohibiting standardization of milk in Wisconsin for the making of American, brick, Limburger or Muenster cheese was passed in 1929, and a companion law requiring all makers to record and report their sales of cream and cheese. Another 1929 Wisconsin law provided for the seizure and making over of illegal (low fat or high moisture) cheese, under supervision of the court and the state dairy official, so as to standardize it into a legal product, before it can be offered for sale. A clean cheese-box law was also passed in 1929. Muenster cheese in Wisconsin may contain 43% moisture plus 1% tolerance, according to another 1929 law. High moisture American cheese may be sold if labeled as prescribed in 1933 law.

(102) Early Methods of Selling Cheese. In the early days, when farmers were entirely unacquainted with the cheese business, buyers visited the factories and bargained for the output, and the ownership and management of the factory and the selling of the cheese were left to the cheesemaker.

In recent years, farmers in some localities have come to understand the details of the business, so that they have gradually taken over, with more or less success, the ownership of the factory, the management of the factory, and the selling of cheese. Combinations of cheese factories for co-operative selling of cheese are now being operated in Quebec, at Tillamook, Oregon, in Wisconsin, and elsewhere, the success depending mainly on the plan of management. U. S. Da. Circ. 572.

(103) Quebec System. In Montreal, Canada, the Quebec Cheesemakers' Cooperative association receives the shipments of cheese from many factories at the association warehouse, sorts the cheese into three grades, checks the weights, and sells the entire receipts at auction to buyers in that city The cheese

judging is done by two chief dairy instructors appointed by the government to manage the two dairy schools, supervise the system of factory inspectors, and inspect the cheese at the cooperative warehouse. This system of inspecting Quebec cheese at the city of Montreal is possible for the reason that this city is the export point, to which the cheese intended for the British market goes for loading on board ship, so that no difficulty is experienced in collecting the cheese at one place.

(104) Federation in Wisconsin. In Wisconsin, there is no one exclusive market or point of shipment, so that the Quebec system appears impossible of application here. In Sheboygan county, the National Cheese Producers Federation was first organized with about fifty incorporated factories as members.

(105) Cheese Boards. At the great majority of American and Canadian factories, cheese is sold each week to a local buyer who agrees to pay the ruling market price established on a specified "cheese board of trade." There have been cheese boards in Wisconsin, located at Plymouth, Sheboygan, Appleton, Muscoda, Spring Green, etc., in New York at Salamanca, Cuba, Watertown, Canton, Utica, etc. and in Canada at Brockville, Cornwall, Belleville, St. Hyacinthe, Quebec, etc. This is a great time saver for the buyers and makers. Formerly, buyers travelled around to each factory and bargained with the makers, who had no means of knowing what prices were offered at neighboring factories, thus causing uncertainty and delay.

At the cheese board meeting, the secretary writes on the blackboard opposite the seller's name, the number of boxes offered of each size cheese. When all sellers have thus posted their offerings, the buyers begin to bid. The secretary writes on the board the highest price offered for each seller's cheese and the bidder's initials, and when the bidding is completed, and everybody is satisfied, the meeting is over, taking less than a half hour of time in most cases. The makers go home and ship the cheese next day to the buyers, who receive and examine the cheese at the warehouse, and bring a check in payment at the next board meeting, or else send it before the meeting by mail.

In this way, without loss of time, the cheese from a number of near-by factories have been sold, and the newspaper reports of prices thus paid are used by many outside factorymen and buyers as a basis for sales.

At cheese boards in some localities in the eastern and northern cheese regions, the meeting has been adjourned after bidding, with all bids withdrawn and no sales made, after which the buyers and sellers make private sales, perhaps at prices

differing from those bid during the meeting. In this case the "board" prices do not represent actual sales. In Wisconsin, sales are generally completed at the board meetings, and the published prices represent genuine sales and market values.

The cheese board serves the factory's interests better when all the factories sell on the board, so that buyers are forced to bid up and compete with each other in order to get cheese to fill their orders. But if a buyer gets cheese from 20 factories at private sale, based on board prices, but buys only 2 or 3 factories' cheese on the board, it is to his interest not to bid too high, but to let the cheese on the board go at a reasonably low figure, even if a competitor gets them, thus keeping the price reasonably low on which the outside factories' sales are based. When properly managed, the cheese board is a great advantage to both buyers and sellers.

(106) Cheesemaking History Repeats. In any dairy section, the cheese industry is likely to go through three stages of development. (1) Its beginning may be in small farm dairies, where cheese is made from the milk of a few cows for family use, or for trading or swapping. The work may be done in a kitchen, and home made utensils used. The cheesemaker may also milk the cows, and perform many other duties.

(2) As the cow population increases, enough milk may become available to require the entire time of the cheesemaker, a special building may be erected to serve as a cheese factory, with some conveniences and appliances which the home factory could not afford. The location may be at any clearing or crossroads central to the sources of milk supply. The equipment may include a self-heating vat, using a wood fire. As milk supplies increase during the passing years, factories become more numerous, located perhaps only 5 or 10 miles apart. Equipment is improved by the introduction of steam boilers, improved vats, pumps or steam jets, agitators or mechanical stirrers for milk and curd, continuous presses, improved hoops, etc. Along with these changes, the marketing of the increased quantities of cheese from a locality changes to a wholesale basis, for shipment and sale of cheese in other states or countries. Standards of quality change. The new demand is for firmer, slow curing cheese which will safely undergo storage and shipment, instead of quick curing, soft cheese for local or home trade. Standards, regulations, laws, schools, licenses, labels, dating stamps, etc., are established. The trained cheesemaker prospers with an ever increasing milk supply over a period of perhaps 30 years or more.

(3) When milk production has become an important part of the work of every farmer, further changes gradually appear.

These include an increased interest among farmers in every detail of the milk business, and an increased demand for milk for other uses, as for buttermaking, for city milk supplies, for the manufacture of condensed milk, etc., all of which tend to limit or reduce the milk supply available at the local cheese factory, and to increase the competition between near-by factories for such milk as is available. Large new plants owned by corporations or farmer cooperatives may enter the field. Hard pressed factories begin trucking milk across country from the territory of other factories. The total number of factories decreases as inefficient factories close. The surviving, highly efficient factories grow larger, and require yet more skillful management to meet increasing competition from new sources. The final stage of development occurs, as in New York state where cheese factories have largely disappeared, and milk supplies are used mainly for city milk and condensary purposes. The cheesemaker is forced to seek another location or state where a newly developing dairy industry may afford again a 40 year longer period between the beginnings and the decline of cheese manufacture. Thus, 50 years ago numerous eastern cheesemakers came to Wisconsin, but in recent years numerous young Wisconsin makers have gone to new dairy states where they now find abundant milk supplies, little competition, and a new chance for continuous, growing employment.

CHAPTER XV.

Whey and Whey Products

(107) Most Factories Skim Whey. In making of Swiss cheese the whey contains .5 to 1.% of fat. It has long been the practice at Swiss cheese factories, wherever located, to skim the whey, formerly by hand, later by milk separators and more recently by the use of the whey separator.

As early as 1908, the manufacture of whey butter at Cheddar factories had made substantial progress in New York.

Since then, nearly every American cheese factory has begun skimming whey and found it profitable.

The fact that no chemical test was available by which whey fat could be distinguished from milk fat, when mixed in butter, ice cream, etc., has made impossible the enforcement of the "whey butter branding law" and has led to the widespread use of whey cream in dairy manufactures. Whey cream has been churned at a few cheese factories, and the butter sold to factory patrons at the cost of churning, but it is now generally sold to commercial cream buyers, as a source of increased income to the factory patron.

(108) Dried Whey. Since 1929, evaporated whey and dried whey have been manufactured in large quantities for use in mixed feeds for pigs, poultry, calves, etc. Whey condensed to contain 50% or 35% solids has been sold in 50, 500, or 600 lb. drums to poultrymen. (Nat. B. & C. Jrnl. Aug. 1941, p. 11)

Whey powder has been made by use of an evaporator to concentrate the whey to a point where it would become solid enough on cooling to allow it to be spread on screens, and dried in a tunnel type drier.

Dried whey may contain about 70% lactose, 12.5% protein, 7 to 11% ash, 3.5 to .5% fat, and about 3% moisture. Recently, surplus whey testing 28 by the lactometer has been sold at small cheese factories for 5 cents per cwt., for the manufacture of dried whey. (U.S.D.A. Circ. 329.)

"There are a number of methods for preparing whey powder but most of them are patented. One method consists of concentrating the whey to between 30 and 50 percent solids in a vacuum pan. The whey is then further concentrated by means of a double drum dryer in which the drums revolve in the opposite direction to that used in the manufacture of dried milk. The taffylike mass is removed from these rolls by scraper blades

or knives and drops to another set of rolls which revolve in the conventional direction. The product which results is quite readily removed by the knives and is flaky and can be easily pulverized.

In another method the whey is concentrated in a vacuum pan to 30 to 50 percent solids and is then forced into a conical dryer but is not completely dried. From there it is passed into a rotating drum together with a small amount of steam. Drying is completed with air.

In any method of drying which may be used, sour whey must first be neutralized before it can be handled in a satisfactory manner. Reduction to a titratable acidity of .08 to .15 is advisable. Where drying is to be carried out with a regular atmospheric drum dryer certain operating difficulties are experienced.

As the whey is placed on the drums the heat will carmelize the lactose and a sticky, gummy mass results. It can be removed only with great difficulty from the rolls. If some film forming material is added to the whey, successful drying is possible. For example, if sweet whey and sweet skim milk are mixed in equal proportions, no drying difficulties are encountered. If sour whey is to be mixed with skim milk it must first be neutralized with an alkali such as sodium hydroxide.

Wheat flour, corn starch, ground oats or ground barley may be used instead of skim milk. The rate at which used will be in the neighborhood of 3.5 to 4.0 pounds per hundred pounds of liquid whey."

The manufacture of primost, ricorta, and similar products from whey is described in chapters XXX and XXXI.

(109) Best Use of Whey. For profit to patrons, the usual use for skimmed whey is to feed it to livestock (91B). If not so used, a maker may often feed whey to his own hogs, with profit.

Whey returned to farms in milk cans should be steamed, either in the whey tank, or by a steam hose in each can filled at the factory. This prevents the infection of milk cans with harmful bacteria, and tends to improve the quality of milk delivered next day in the cans, whether the patron forgets to wash the cans or not.

Lifting whey to the separator and to the whey tank with two steam jets heats it sufficiently in many cases, before it reaches the whey tank.

CHAPTER XVI.

Figuring Payments for Cheese Factory Milk

Excepting a very few factories, which still continue to pay by the pooling system, the great majority of cheese factories in America figure payments for milk by the straight fat system. However, a very few factories in this country and a larger number in Canada use the fat plus 2% method. A small number, having both Holstein and Guernsey cows have adopted the fat plus six-tenths method for use under their special conditions. (68F to 68R.)

(117) The Main Purpose. The first aim in selecting a method of figuring payments is to pay each patron in proportion to the cheese yield from his milk. Under conditions existing at the great majority of factories, the straight fat method of figuring does this, to the satisfaction of all the patrons. For discussion of cheese yield see chap. IX.

(118) Secondary Purposes. (1) Prevention of Watering or Skimming. To discourage the skimming or the watering of milk, the straight fat method is said to be the best, because watering alone does not change a patron's payment, and skimming alone reduces the payment, when figured by the straight fat method. On the other hand, by use of the fat plus 2%, or fat plus .6% method of figuring, a patron can increase his payment by watering. For example, 100 lbs. of 4.5% milk may be worth, at 35 cents per lb. for fat plus 2%, .35 times 6.5 or \$2.27½, but by adding 50 lbs. water the patron would be paid for 1.5 x .35 x 5., or \$2.62½.

(2) Detection of Other Adulteration. By use of both the lactometer (17C) and the fat test, can be detected the adulteration which adds cream and water to milk, while keeping skim milk on the farm. (3) Detection of Dirt. (17G).

(119) Calculating Payments by the Straight Fat Method. To calculate the amount of money to be paid by the straight fat method to each patron at a factory it is necessary first to add the receipts from all sales made during the month, and subtract from this sum the expenses, including supplies, labor, etc., as for example:

Total sales, month of June	\$2,101.23
Total expenses, month of June	175.00
Proceeds to be divided among patrons	\$1,926.23

This amount of money, $1,926.23, is to be divided among the patrons in proportion to the weight of butterfat delivered by each. At most factories, composite samples of the milk delivered by each patron are tested twice a month. To calculate how much money each man should receive, it is necessary first to add up the columns of the factory milk sheet shown below to find out how many pounds of milk each patron delivered during the first and second halves of the month.

Patron's No.	1	2	3	4	5	6	7	8	9	10
Date June, 1929	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk	Lbs. Milk
1	215	420	130	557	698	936	1548	317	811	1400
2	210	425	124	543	687	980	1537	324	820	1393
3	216	419	139	569	700	975	1530	333	831	1380
4	210	427	127	557	682	983	1550	325	815	1410
5	213	410	120	550	674	989	1545	323	827	1390
6	215	425	128	561	683	995	1560	329	809	1427
7	221	435	137	569	690	1018	1572	330	819	1438
8	232	430	130	574	698	992	1558	337	831	1395
9	236	428	133	565	680	987	1568	330	837	1396
10	223	420	137	563	703	985	1580	324	822	1358
11	222	431	146	579	694	979	1589	338	814	1400
12	245	435	140	570	687	996	1576	345	809	1430
13	236	439	150	583	675	990	1539	350	828	1411
14	229	447	143	580	624	1019	1580	337	835	1436
Total Milk	3123									
Test %	4.2	4.4	3.8	4.1	3.7	3.6	3.5	3.2	3.8	3.9
Lbs. Fat	131.2									
15	220	450	153	585	695	1007	1575	350	840	1470
16	215	445	159	597	693	995	1587	347	851	1462
17	206	453	152	580	704	990	1596	358	838	1497
18	197	462	147	583	711	999	1584	363	847	1460
19	190	465	158	590	725	1011	1593	355	859	1475
20	180	460	150	599	698	1015	1580	347	850	1483
21	180	455	141	587	700	992	1603	359	862	1479
22	175	465	158	580	715	989	1592	363	852	1470
23	180	469	162	593	704	996	1610	354	845	1465
24	172	473	168	585	719	990	1619	359	858	1475
25	181	462	158	579	711	998	1597	352	849	1480
26	189	475	167	570	730	986	1618	348	851	1473
27	182	467	154	578	725	979	1595	340	857	1481
28	170	453	169	585	739	974	1589	346	846	1490
29	178	478	153	592	747	995	1611	341	843	1470
30	185	488	160	597	732	1010	1620	350	870	1486
Total Milk	3010									
Test %	4.1	4.1	3.7	4.3	3.4	3.8	3.6	3.3	3.5	3.6
Lbs. Fat	123.4									
Total fat for month	254.6									

The factory milk sheet at the end of the month shows the total fat delivered by patron No. 1. The reader may complete the calculation for the other nine patrons.

From the record of weights and tests upon the milk sheet for patron No. 1, it is seen that between June 1 and 14 he delivered 3,123 pounds of milk, testing 4.2 per cent, which con-

tained 131.2 pounds of fat. Between June 15 and 30 he delivered 3,010 pounds of milk testing 4.1 per cent fat or 123.4 pounds of fat, making a total of 254.6 pounds of fat during the month. Often, the total month's milk added together, is multiplied by the average of the two tests made twice in the month. When the weights of milk are quite uniform throughout the month, this may be satisfactory. In a similar way can be found the weight of fat delivered by each of the ten patrons during the month. Add these all together to find the total weight of butterfat delivered at the factory as follows:

Patron's Number	Pounds fat delivered
1	254.6
2	567.5
3	----
4	----
5	----
6	----
7	----
8	----
9	----
10	----
Total pounds fat	8,175.4

Dividing the proceeds, $1,926.23, by the total number of pounds of fat delivered, 8,175.4, gives the price to be paid the patrons for each pound of butterfat delivered, which in this case is $.2356.

The amount of money due each patron is found by multiplying the number of pounds of fat he delivered, by the price of butter fat, in this case $.2356, as shown below.

Patron's number	Pounds fat delivered	Price per pound for butter fat	Amounts due the patrons
1	254.6	Multiplied by $0.2356	$ 59.98
2	567.5	" " "	--------
3	----------	" " "	--------
4	----------	" " "	--------
5	----------	" " "	--------
6	----------	" " "	--------
7	----------	" " "	--------
8	----------	" " "	--------
9	----------	" " "	--------
10	----------	" " "	--------
Total	8,175.4	Total	$1,926.11

The patrons are entitled to the amounts given in the last column and there remain also 12 cents undivided, which amount is carried over to the following month, as cash on hand.

A valuable exercise for students is to figure out the amount of money due to each patron in the list above, according to the method there used. Practice to figure rapidly and accurately.

In addition the payments for the same milk may be figured by the fat plus two, the fat plus six-tenths method, and by the pooling system, to see if the differences are large enough to be of importance for any patron.

After figuring the payments by two methods for a patron, subtract the smaller from the larger, and divide the difference by the payment. The quotient shows the difference, in cents per dollar paid. If this is not over 2 cents per dollar for any patron in the list, the straight fat method, being the simplest, may as well be used. If the difference amounts to 5 or 10 cents on the dollar, as it may at some factories where both Holstein and Jersey cows supply the milk, some other method of figuring may be adopted. See chapter IX.

(119A) The Highest and Lowest Fat Tests at Different Factories. Reports were collected during recent years from cheesemakers in different parts of Wisconsin showing the fat test on which the payment was based, and from which the factory average test could be calculated.

Comparing each patron's test with the corresponding factory average test, the results fall into groups as shown in the table below.

SUMMARY OF PATRONS' FAT TESTS BY GROUPS

Group	Patrons' fat tests differ from the factory average test for the month by	Number	per cent of total number
1	0.0 to 0.5 per cent fat	14277	94.97
2	0.51 to 0.75 per cent fat	567	3.77
3	0.76 to 1.00 per cent fat	127	0.84
4	More than 1 per cent fat	62	0.42
	Total	15033	100.00

From this it is seen that in 95 per cent of all cases studied, the patron's fat test falls in group 1, differing by .5 per cent or less from the factory average test.

From the facts shown above, it is clear that the Babcock test method of figuring is giving satisfactory payments for milk, in at least 95 per cent of all factories studied.

(120) The Fat Plus 2 Method. This was first proposed and used in Canada. To illustrate the use of the method, five patrons are each assumed to deliver 100 pounds of milk, which yielded 53 lbs. of cheese, selling at 23 cents per pound, with 3 cents paid for making. Thus there was $10.60 to divide among the patrons.

Patron No.	1	2	3	4	5	Total
Fat test, %	3.0	3.5	4.0	4.5	5.0	
Fat test plus 2%	5.0	5.5	6.0	6.5	7.0	
Lbs. fat plus 2	5.0	5.5	6.0	6.5	7.0	30.0

Dividing $10.60 by 30 gives 35.33 cents, the price per lb. Multiplying this price by each patron's weight of "fat plus 2," gives the following values for the different lots of milk:

$1.766	$1.943	$2.12	$2.296	$2.473	$10.598

Fat plus two does not imply that there is 2% casein in milk.

(121) Payments for Fat and Casein in Milk. Instead of paying for the weight of cheese which the milk yields, Van Slyke and others have proposed to pay for milk in proportion to its content of fat and casein, assuming that the cheese from 3, 4, and 5% milks all contain the same percentage of moisture. These methods are not used to any great extent at present in figuring payments, but a description of them is perhaps of interest to the reader. The list of such methods includes (1) Van Slyke's fat plus calculated casein method of figuring, (2) the fat plus six-tenths method of figuring which gives the same money payments at the latter, (3) Hart's proposal to test all milks for both fat and casein, add the tests, and base payments on the sum of the two figures. To figure payments by the fat plus six-tenths method, the same plan is used as described in (120) except that .6% fat is added to each patron's fat test, instead of 2%.

Patron No.	1	2	3	4	5	Total
Fat test %	3.0	3.5	4.0	4.5	5.0	
Fat test plus .6%	3.6	4.1	4.6	5.1	5.6	
Lbs. fat, plus .6	3.6	4.1	4.6	5.1	5.6	23.0

Dividing $10.60 by 23 gives 46.087 cents, the price per pound. Multiplying this price by each patron's weight of "fat plus .6" gives the following payments for the milks.

$1.659	$1.889	$2.12	$2.350	$2.581

(121A) "Costed Cheese System of Payment." This plan proposed in New Zealand, (Dairy Research Institute (N. Z.) Publication 66) requires the use of an improved form of the Walker Casein test (17E), and the calculation for each patron of his share of the cheese money, less his share of the expense of making cheese including the cost of vat space used, bandages, boxes, etc., under New Zealand conditions.

(122) Comparison of Four Methods of Payment. For comparison, the prices for 100 lbs. of milk, figured by the four methods above, are shown here.

Milk test	3.0%	3.5%	4.0%	4.5%	5.0%
Straight Fat Pay	$1.59	$1.855	$2.12	$2.385	$2.65
Fat plus .6%	1.66	1.89	2.12	2.35	2.58
Fat plus 2.%	1.76	1.94	2.12	2.30	2.48
Pooling System	2.12	2.12	2.12	2.12	2.12

By comparison of the figures above, it is seen that with the price of cheese (paid to the patrons) at 20 cents per pound, the difference of price for 100 lbs. milk, between 3% milk and 4% milk, is 53 cents under the straight fat plan, is 46 cents under the fat plus .6 plan, and is 36 cents under the fat plus 2.% plan.

For a difference of .1% fat in milk test, the difference in price per 100 lbs. is 5.3 cents under the straight fat plan, 4.6 cents under the fat plus .6 plan and 3.6 under the fat plus 2.% plan, or 0.0 cents under the pooling system. These figures are often called the "price per point."

(123) The "Point" Method of Figuring Milk Payments. Some condensaries, city milk plants, and cheese factories who are neighbors to such plants use this method of figuring the price of 100 lbs. milk of any fat test. (1) The average price of 100 lbs. milk is figured by dividing the total patrons money by the total weight of milk. (2) The average fat test is figured by dividing the total weight of fat by the total weight of milk. For example, assume that the average price thus figured is $2.12, and the average test is 4%. With the price of 100 lbs. 4% milk thus set at $2.12, how much higher shall the price be for 4.1% test milk? What "price per point" shall be used?

The plant management, or the factory patrons, may set any figure they choose for the "price per point." From (122) it is seen that if the chosen figure be 5.3 cents, the prices for all milks will be the same as if figured by the straight fat method. If 4.6 cents is chosen, the payments will be the same as if they had been figured by the fat plus .6% method, under these conditions.

It will be seen at once that the larger the figure chosen as the "price per point," the higher will be the price per 100 lbs. for high test milk, the lower will be the price per 100 lbs. for low test milk, and the greater will be the difference between the prices of high test and low test milks. Since too large a difference in prices paid to different patrons may cause dissatisfaction to the low test patrons, the "price per point" may be set at any chosen figure, as 5, 4, or 3 cents, arbitrarily, without reference to cheese yield considerations, but merely to satisfy all patrons. The total amount of money paid out will be the same in either case whether the price per point is chosen high or low.

A factory which has been using the pooling system, and thus paying the same price per 100 lbs. for milk of any test, and which votes to base the payments on the fat test in the future, may find that straight fat payments, or a price per point of 5.3 cents, reduces the price of low test milk so far below the price formerly paid under the pooling system, as to create dissatisfac-

tion among the low test patrons. To avoid this, it may be decided by vote of the patrons to set the price per point at 5, 4, or 3 cents, or at any figure lower than 5.3 cents. For example, assume that 4 cents was the figure chosen. Assume also that the market price of cheese at that time was 22 cents, the cost of making 2 cents, and the price per lb. cheese to patrons was 20 cents (total patrons' money divided by weight of cheese sold).

(124) "Price per Point" Should Change with Price of Cheese. With 4 cents as the "price per point" added to the milk price for an increase of .1% fat, there will be 40 cents added for an increase of 1.% fat. As the cheese price was 20 cents, it is clear that the added 40 cents is the value of TWO pounds of cheese. Now, if we look in column 1 of table A, and find the figure 2 lbs. (on the eighth line) and look along this line toward the right, we find in each column the correct "price per point," corresponding to the price of cheese at the head of the column, and always equal to 1/10 of the value of 2 lbs. of cheese, at the given market price. Thus, with price of cheese at 30 cents, the "price per point" is 6 cents, with cheese at 20 cents the "price per point" is 4 cents, at 15 cents it is 3 cents, and at 10 cents it is 2 cents. The purpose here is to show why and how much the "price per point" should change according to the changes in price of cheese, when this "point" method of figuring payments is used.

At some factories, the patrons neglect changes in the price of cheese, and vote once a year on the "price per point." Patrons who wish to be paid according to the cheese yield of their milk, especially the high test patrons, should prefer that the "price per point" should be changed as the price of cheese changes, or that payments be made by the straight fat method.

Since the straight fat method of payment is the easiest to figure, understand, and explain, and since it is giving entire satisfaction at about 95% or more of all cheese factories, it seems likely that the "straight fat system" of payment should and will continue in general use, excepting under unusual conditions existing at a few plants.

(125) Payment for Milk, Selling Cream and Dry Casein. The cream or butter money can be distributed to the patrons exactly right by the straight fat method. How much of an error will be introduced if the casein money is added to the cream money, thus paying for casein in proportion to the fat test of each milk?

If the casein test of milk increased at the same rate as the fat test, as in the following table, where the casein is always .6 of the fat,

TABLE A. HOW THE "PRICE PER POINT" VARIES WITH THE CHEESE PRICE.

(Col. 1) Difference in Yield	PRICE PER LB. CHEESE PAID TO PATRONS — MARKET PRICE LESS COST OF MAKING											(Col. 1) Difference in Yield
	30 cents	29 cents	28 cents	27 cents	26 cents	25 cents	24 cents	23 cents	22 cents	21 cents	20 cents	
	DIFFERENCE PER TENTH % FAT, IN PRICE PER HUNDRED POUNDS OF MILK											
Lbs.	cents	cents	cents	cents	cents	cents	cents	cents	cents	cents	cents	Lbs.
2.65	7.95	7.625	7.42	7.155	6.89	6.625	6.36	6.095	5.83	5.565	5.30	2.65
2.6	7.80	7.54	7.28	7.02	6.76	6.50	6.24	5.98	5.72	5.46	5.20	2.6
2.5	7.50	7.25	7.00	6.75	6.50	6.25	6.00	5.75	5.50	5.25	5.00	2.5
2.4	7.20	6.96	6.72	6.48	6.24	6.00	5.76	5.52	5.28	5.04	4.80	2.4
2.3	6.90	6.67	6.44	6.21	5.98	5.75	5.52	5.29	5.06	4.83	4.60	2.3
2.2	6.60	6.38	6.16	5.94	5.72	5.50	5.28	5.06	4.84	4.62	4.40	2.2
2.1	6.30	6.09	5.88	5.67	5.45	5.25	5.04	4.83	4.62	4.41	4.20	2.1
2.0	6.00	5.80	5.60	5.40	5.20	5.00	4.80	4.60	4.40	4.20	4.00	2.0
1.9	5.70	5.51	5.32	5.13	4.94	4.75	4.56	4.37	4.18	3.99	3.80	1.9
1.8	5.40	5.22	5.04	4.86	4.68	4.50	4.32	4.14	3.96	3.78	3.60	1.8
1.7	5.10	4.93	4.76	4.59	4.42	4.25	4.08	3.91	3.74	3.57	3.40	1.7
1.6	4.80	4.64	4.48	4.32	4.16	4.00	3.84	3.68	3.52	3.36	3.20	1.6
1.5	4.50	4.35	4.20	4.05	3.90	3.75	3.60	3.45	3.30	3.15	3.00	1.5
1.4	4.20	4.06	3.92	3.78	3.64	3.50	3.36	3.22	3.08	2.94	2.80	1.4
1.3	3.90	3.77	3.64	3.51	3.38	3.25	3.12	2.99	2.86	2.73	2.60	1.3
1.2	3.60	3.48	3.36	3.24	3.12	3.00	2.88	2.76	2.64	2.52	2.40	1.2
1.1	3.30	3.19	3.08	2.97	2.86	2.75	2.64	2.53	2.42	2.31	2.20	1.1
1.0	3.00	2.90	2.80	2.70	2.60	2.50	2.40	2.30	2.20	2.10	2.10	1.0

(Col. 1) Difference in Yield	PRICE PER LB. CHEESE PAID TO PATRONS — MARKET PRICE LESS COST OF MAKING										(Col. 1) Difference in Yield
	19 cents	18 cents	17 cents	16 cents	15 cents	14 cents	13 cents	12 cents	11 cents	10 cents	
	DIFFERENCE PER TENTH % FAT, IN PRICE PER HUNDRED POUNDS OF MILK										
Lbs.	cents	cents	cents	cents	cents	cents	cents	cents	cents	cents	Lbs.
2.65	5.035	4.77	4.505	4.24	3.975	3.71	3.445	3.18	2.915	2.65	2.65
2.6	4.94	4.68	4.42	4.16	3.90	3.64	3.38	3.12	2.86	2.60	2.6
2.5	4.75	4.50	4.25	4.00	3.75	3.50	3.25	3.00	2.75	2.50	2.5
2.4	4.56	4.32	4.08	3.84	3.60	3.36	3.12	2.88	2.64	2.40	2.4
2.3	4.37	4.14	3.91	3.68	3.45	3.22	2.99	2.76	2.53	2.30	2.3
2.2	4.18	3.96	3.74	3.52	3.30	3.08	2.86	2.64	2.42	2.20	2.2
2.1	3.99	3.78	3.57	3.36	3.15	2.94	2.73	2.52	2.31	2.10	2.1
2.0	3.80	3.60	3.40	3.20	3.00	2.80	2.60	2.40	2.20	2.00	2.0
1.9	3.61	3.42	3.23	3.04	2.85	2.66	2.47	2.23	2.09	1.90	1.9
1.8	3.42	3.24	3.06	2.88	2.70	2.52	2.34	2.16	1.93	1.80	1.8
1.7	3.23	3.06	2.89	2.72	2.55	2.38	2.21	2.04	1.87	1.70	1.7
1.6	3.04	2.88	2.72	2.56	2.40	2.24	2.08	1.20	1.10	1.60	1.6
1.5	2.85	2.70	2.55	2.40	2.25	2.10	1.95	1.92	1.76	1.50	1.5
1.4	2.66	2.52	2.33	2.24	2.10	1.96	1.82	1.68	1.54	1.40	1.4
1.3	2.47	2.34	2.21	2.08	1.95	1.82	1.69	1.56	1.43	1.30	1.3
1.2	2.28	2.16	2.04	1.92	1.80	1.68	1.56	1.44	1.32	1.20	1.2
1.1	2.09	1.98	1.87	1.76	1.65	1.54	1.43	1.32	1.21	1.10	1.1
1.0	1.90	1.80	1.70	1.60	1.50	1.40	1.30	1.80	1.65	1.00	1.0

Fat test %	3.0	3.5	4.0	4.5	5.0
(a) Casein % (.6 x fat)	1.8	2.10	2.4	2.70	3.0

then it would be exactly right to pay out both cream and casein money by the straight fat method. But the average casein test varies about as follows.

Fat test %	3.0	3.5	4.0	4.5	5.0
(b) Average casein %	2.14	2.27	2.40	2.53	2.66

If your factory fat tests differ by 2% fat between the highest and lowest, then by the straight fat method, you would distribute the 12 lbs. of casein, or $1.20 in money as follows, for 100 lb. lots of milk.

Casein pay by (a)	18c	21c	24c	27c	30c
whereas they should be paid according to (b)					
Casein pay correct	21.4c	22.7c	24c	25.3c	26.6c

If the casein money payment is to be figured separately, it can be distributed according to fat test plus 2.25%, where no casein test is used in the factory.

(126) Payment for Milk, Selling Butter and Milk Powder. Where butter is made, and also skim milk powder from the same milk at the same creamery, the butter sales money less the expense and plant profit may be returned to the farmers, at uniform price per pound of butterfat, multiplied by the weight of fat in each patron's milk.

The money from the sale of skim milk powder, less the expense and the plant expense and profit, can be divided among the farmers at a uniform price per pound of solids-not-fat, multiplied by the weight of solids-not-fat in each farmer's milk.

The simplest way to figure the farmer's weight of solids-not-fat in normal milk is to multiply his weight of milk by the per cent of solids-not-fat taken from a table or chart such as that prepared by Harry Klueter, Wisconsin Dairy and Food Commission chemist, from the average of analysis of 616 samples of milk, as follows,

% Fat	2.5	3.0	3.5	4.0	4.5	5.0
% S. N. F.	6.0	8.25	8.5	8.75	9.0	9.25

Above 4% fat, the number of samples was relatively small, and there may be some slight variation from the figures between 4 and 5% fat, for the average content of solids-not-fat shown in the table. If the figures in the table are used, the chart curve is a straight line, and the formula connecting fat % and average solids-not-fat % is as follows:

½ (Milk fat test % plus 13.5%) equals average % solids-not-fat. The use of Klueter's complete chart makes the formula unnecessary.

Some of the milk solids-not-fat may be lost, as in the buttermilk, but this loss of weight need not modify the calculation method, since the loss will be reflected in a reduced price per pound figured for solids-not-fat.

(127) Payment for Standardized Milk and for Cream. The following question was proposed to the writer by Harry Klueter, Chief Chemist, Dairy and Food Commission, in April, 1928. Where the vat of milk is standardized, is it possible to pay each patron for the cream sold from his milk, and also to figure his payment for his standardized milk by the straight fat method?

To do this, assume for illustration that 3 patrons brought each 1,000 lbs. of milk, testing 3, 4, and 5% fat and 2.14, 2.40, and 2.66% casein. The ratios of casein to fat are: .713, .60, and .532 respectively. Assume that the vat of milk is standardized to a C/F ratio of .713.

The calculation is as follows:

Lbs. milk	Fat %	Cas %	C/F ratio	Standardize to ratio	Lbs. fat present	Lbs. fat should be	Lbs. to skim out fat	Lbs. to skim out cream
1,000	3.0	2.14	0.713	0.713	30.0	30.0	0.0	0.0
1,000	4.0	2.40	0.60	0.713	40.0	33.7	6.3	13.0
1,000	5.0	2.66	0.532	0.713	50.0	37.3	12.7	26.0
					120.0	101.0	19.0	

Run through the separator (19.00/.04, or 475) lbs. vat milk, taking a 50% cream. Put back the skim milk. Pay for

Patron No.						
1	1,000 lbs.	3 %	milk	and	no	cream
2	987 lbs.	3.42%	milk	and	6.3	lbs. cream fat
3	974 lbs.	3.83%	milk	and	12.7	lbs. cream fat
				Total	19.0	lbs. cream fat

Distribute the cheese money by the straight fat method, and pay each patron also for his cream, if any, as above.

If all the milks in the vat were standardized to C/F .80,

Pounds milk	Fat %	Cas %	C/F ratio	Standardize to	Lbs. fat present	Lbs. fat should be	Skim out lbs. fat
1,000	3.0	2.14	0.713	0.80	30.0	26.7	3.3
1,000	4.0	2.40	0.60	0.80	40.0	30.0	10.0
1,000	5.0	2.66	0.532	0.80	50.0	33.2	16.8
					120.0	89.9	30.1

Skim (30.1/.04 equals 752.5) lbs. vat milk. Put back the skim milk. Pay

Patron No.	Lbs.	%	Milk Lbs. fat	Lbs. cream fat
1	993	2.68	26.7	3.3
2	980	3.06	30.0	10.0
3	966	3.43	33.2	16.8
			89.9	30.1

Pay out the cheese money by the straight fat method, and add the cream money to the check.

CHAPTER XVII.

Curing Room Conditions and Work

(133) Curing Agents. Cheese in curing becomes more soluble in water, waxy or liquid in texture instead of curdy, and develops flavor. The flavor of cured cheese gradually increases and may finally become so intense as to be offensive. These changes are caused by various agents, including native milk enzymes, such as galactase, (Babcock and Russell, Wis. Annual Rept., 1897) and also rennet enzymes, bacteria, bacterial enzymes, acid, and molds, growing in or on cheese. During the first ten to fourteen days of curing the bacteria increase rapidly to numbers as high as 1,000 billion per gram, and later gradually decrease. (Hastings, Evans and Hart, Wis. Res. Bul. 25.) Curing is delayed by salt and cold, and hastened by moisture in the cheese, and warmth. Success in ripening cheese depends partly (1) on the way the cheese is made as to moisture content, acid and cleanliness, and partly on (2) temperature and (3) humidity under which it is cured. N. Z. Dairy Research Institute, Pub. 56-62.

Experiments with 3 and 5 ounces of rennet (per 1,000 lbs. milk) reported in N. Z. Dairy Res. Inst. Pub. 33, 56, 62, showed that high rennet cheese were more mellow in body in 14 days, but later developed a sticky condition. The high rennet cheese showed more flavor (in 14 weeks), but not real Cheddar flavor. The use of additional rennet is an advantage when cheese is to be sold young.

A good raw milk cheese develops a mature Cheddar flavor earlier than does a pasteurized milk cheese. At present however to dispense with pasteurization would often result in a general deterioration in the flavor of cheese. Flash pasteurizing temperatures should be kept within the range of 155 to 165, F., since higher temperatures give increased interference with normal development of Cheddar flavor.

Very dry cheese, as Saanen, may require one to six years for curing to ripen fully. The English market prefers cheese ripened for several months or a year. American cheese containing 36 to 40% moisture often reaches the consumer at an age of one month, in accordance with the modern tendency to market such products as early as possible. Holding American cheese several hours at the temperature of the vat before putting it to press cures the cheese more than a much longer time at the lower temperature of the curing room. The use of more salt delays curing somewhat.

In the past, makers have believed that the use of more rennet hastens curing, but recent studies indicate that varying the amount of rennet or pepsin appeared to have little effect on the flavor, texture, body or ripening of cheese. (Jour. Dairy Res. (1934) 152.)

Heating curds to 100 degrees with hot water before salting, and putting it to press warm has been observed to promote the curing process, and to close the cheese better.

(134) Curing Room Temperature. The temperature in the curing room should be regulated. Curing goes on more rapidly at higher temperatures, but generally with injury to quality if above 65 degrees excepting with Swiss cheese. On the other hand, cheese cures more slowly at lower temperatures, down to 34 degrees F., but without injury to the quality of American cheese, which fact was first demonstrated at the Wisconsin station, by Dr. S. M. Babcock.

The curing room of the ordinary American cheese factory in Wisconsin is really a storage and drying room in most cases, where cheese are kept for only a few days (3 to 10 days) until dry enough on the surface and until a suitable quantity is obtained for shipment to the buyer. In summer cheese are sold weekly, and shipped twice a week. Such factory curing room temperatures may go as high as 80-90 in summer, and an accidental delay in shipping through lack of boxes or cars may cause serious injury to the quality of cheese and undue shrinkage in weight.

Such conditions are avoided in many well built curing rooms in Canada and elsewhere, having stone walls two feet thick, and provided with an adjacent ice house, from which cool air can be circulated through the cheese room, when necessary, to maintain a temperature of about 60-65 degrees for the best quality of cheese.

Wisconsin storage warehouses, where cheese are kept for 6 months or more, are held at about 34 degrees by use of mechanical refrigeration, or at 40 to 50 degrees by the use of ice or ice and salt. The Canadian cool-curing warehouses are kept at 55-60 degrees F.

Means employed to cool the factory curing room a few degrees include: (1) Running 1½-inch galvanized iron pipes several times along the curing room walls and connecting them to the pump, so that all water pumped at the factory is used first for cooling the curing room. (2) A rack at one side of the room into which a few cakes of ice can be placed when needed, is used at several factories. (3) A sub-earth duct, as at the factory of P. H. Kasper, Bear Creek, Wis., consisting of thirteen parallel

lines of drain tile 108 feet long buried nine feet underground, is connected to a stack provided with a revolving cowl, which always faces the wind. The air passing down the stack and cooled through the tile, is delivered (sometimes by an electric fan) into the curing room, which is thus well cooled. A similar arrangement consists in conducting the air from the stack down a pipe into a deep well, while the air issuing from the top of the well passes out into the curing room. (4) Factories located near a pond or stream can easily store ice in winter and a cheese storage room is sometimes built in so as to be covered with ice as long as any is left in the ice house. (5) Some modern factories have ice machines and circulate brine for a short time each day through cooling pipes around the walls.

(6) A modern plan is to insulate the walls, ceiling and floor with 2 to 4 inches of cork, and then control both the temperature and humidity by blowing the air of the room through the cooling coil of a small refrigerating machine, to cool the air and also condense the air moisture to liquid water, which runs into the drain.

Increase of annual income by $1,545 is estimated, from increased yield and improved quality and price, for a factory making 255,500 lbs. cheese per year. (Nat. C. & B. Jrnl., Oct. 1939, p. 15.)

Swiss cheese are sometimes cured at temperatures at or above 90 degrees, to produce "eyes."

(135A) Freezing Point of Cheese. American cheese freezes at about -5 to -14 degrees Centigrade, depending on the age of the cheese and the content of moisture and of salt. Sommer, Jrnl. Dairy Sci. (1928) p. 9. On storage at favorable temperatures after freezing, the texture recovered, in some cases, apparently completely.

(135B) Curing Room Pests. The "cheese skipper" is the maggot which hatches from the egg of the cheese fly. The peculiar habit of the "skipper" maggot is to curve the ends of its body together, and then suddenly straighten and thus spring to a distance of 3 to 6 inches. The maggot goes into a dormant, pupa stage for a few days and then emerges as a cheese fly, which is smaller than the ordinary house-fly. Cal. bul. 343.

The brown powder often seen on old cheese consists mainly of the bodies of cheese mites, which can be distinguished under a magnifying glass.

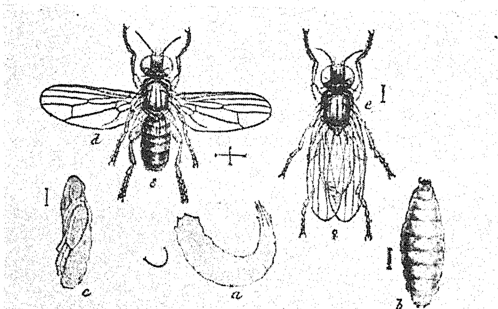
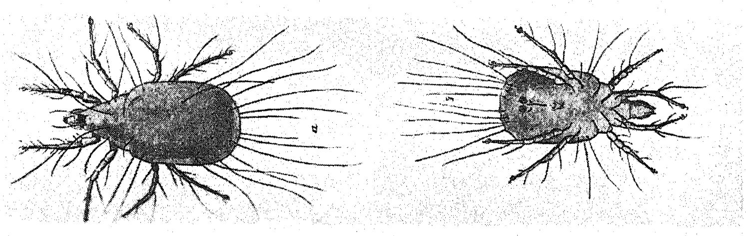


FIG. 58.—*Piophila casei*: a, larva; b, puparium; c, pupa; d, male fly; e, female with wings folded—all enlarged (original).

Mites are more resistant to cold than cheese flies. Temperatures of 30 to 36 F. prevent loss through mites, flies, or skippers. Cheese is often placed at 50 to 60 degrees for several weeks,



then stored at 30 to 34 degrees. Wire screen cloth (24 mesh) on windows, frequent cleaning of cheese shelves, and occasional fumigation are means to avoid these pests, at the cheese factory, but cold is preferable. Nat. B. and C. Jrnl., Apr. 1940, p. 17.

(136) Curing Room Humidity. The humidity of the curing room is of importance, since with too dry air the shrinkage in weight may be excessive and both yield and quality reduced, while with too moist air the cheese rapidly become moldy on the surface and do not dry properly or form a rind.

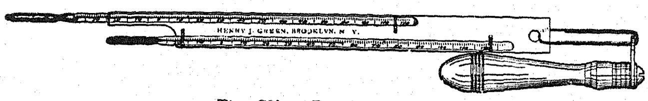
As the outside air in this country is usually much drier than necessary for cheese curing it is best to keep the curing room closed most of the time. In summer this is an advantage also in keeping the room cooler than the outside air. When the nights are cooler than the days in summer the room may be ventilated to remove the moist air by opening windows at night.

After American cheese are well dried on the surface they are paraffined and returned to the cheese boxes in which they are kept during storage. The dry rind and the paraffine coating check the growth of mold, and storage in the box also checks further drying out.

The humidity of air where soft cheese as Limburger, Brie, etc., are cured is higher than for American cheese in order to keep soft cheese from drying out. A curing room is more easily kept moist if it is nearly filled with cheese. Where only a few soft cheese are made, a small room or closet is best, or the cheese may be kept covered with a wooden box moistened inside to protect them from air currents. A spray of water or jet of steam may be kept flowing from a nozzle through the air, or the floor may be kept wet, or wet cloths may be hung up. In France, where Brie and Camembert cheese are made in large quantities, the factory windows may be kept open because the air is always naturally moister, due to sea winds, than in the eastern part of this country. To destroy molds in the curing room fumigate with burning sulphur or formalin gas or Cyanegg, a du Pont product, or scrub with a hypochlorite solution and then whitewash the walls and ceiling, and keep the room drier by better ventilation to prevent new growth. (134)

(136B) High Moisture Content in Cheese promotes rapid curing, short life and early spoilage. Thus cottage or Neufchatel cheese with 65-75% moisture may spoil in 1 or 2 weeks, Limburger cheese with 45-48% moisture may cure in six weeks, brick cheese with 42% moisture cures in 2 month, American cheese with 39-42% moisture is often eaten when one month old, while export American or Swiss cheese with 35% moisture keeps well and continues to cure and improve in quality for 6 to 12 months or longer. Curing room conditions are regulated to avoid getting each kind of cheese too dry or too wet.

(136B) Measuring Humidity. The humidity of air in the curing room can be judged by the absence or presence of mold. It can be measured by use of the hygrometer or by a pair of wet and dry bulb thermometers, which arrangement is called a



The Sling Psychrometer

psychrometer, the best form of which is the sling psychrometer which is whirled rapidly by hand in the air. The lower thermometer bulb is covered with a cloth dipped in water each time before use. In the dry room the water on the wet thermometer bulb evaporates rapidly causing a cooling effect so that the wet bulb thermometer reads lower than the one with a dry bulb. The greater the difference in reading between the two thermometers the drier the air is in the room. If the air is saturated

with moisture there will be no evaporation from the wet bulb and the two instruments will read alike. The per cent of humidity may be read from the following table. If the humidity is above 90%, cheese are likely to become moldy in a short time.

(137) Table Showing the Relative Humidity of Air.

Directions. Notice that the table is in three column sections. Find air temperature in first column, then find wet bulb temperature in second column, same division. In third column opposite this is relative humidity, percentage of saturation.

Example. Air temperature is 50 degrees, in first column; wet bulb is 44 degrees, in second column, same division. Opposite 44 degrees is 61, which is the per cent of saturation, or the relative humidity of the air.

HUMIDITY IN THE AIR OF CURING ROOM

Dry Bulb	Wet Bulb	Rel. Hum.
40	32	37
	33	44
	34	52
	35	59
	36	68
	37	76
	38	84
	39	92
41	32	31
	33	38
	34	46
	35	53
	36	60
	37	68
	38	76
	39	84
	40	92
42	33	33
	34	40
	35	47
	36	54
	37	61
	33	69
	39	77
	40	84
	41	92
43	33	28
	34	34
	35	41
43	36	48
	37	55
	38	62
	39	70
	40	77
	41	85
	42	92
44	34	29
	35	36
	36	43
	37	49
	38	56
	39	63
	40	70
	41	78
	42	85
	43	92
45	35	31
	36	37
	37	44
	38	50
	39	57
	40	64
	41	71
	42	78
	43	85
	44	92
46	35	26
	36	32
46	37	38
	38	45
	39	51
	40	58
	41	65
	42	72
	43	79
	44	85
	45	93
47	36	28
	37	34
	38	40
	39	46
	40	52
	41	59
	42	66
	43	72
	44	79
	45	86
	46	93
48	37	29
	38	35
	39	41
	40	47
	41	53
	42	60
	43	66
	44	73
	45	79
	46	86
	47	93
49	38	30
	39	36
	40	42
	41	48
	42	54
	43	60
	44	67
	45	73
	46	80
	47	86
	48	93
50	39	32
	40	37
	41	43
	42	49
	43	55
	44	61
	45	67
	46	74
	47	80
	48	87
	49	93
51	40	33
	41	39
	42	45
	43	50
	44	56
	45	62
	46	68

HUMIDITY IN THE AIR OF CURING ROOM—Continued.

Dry Bulb	Wet Bulb	Rel. Hum.
51	47	74
	48	81
	49	87
	50	93
52	41	35
	42	40
	43	46
	44	51
	45	57
	46	63
	47	69
	48	75
	49	81
	50	87
	51	94
53	41	31
	42	36
	43	41
	44	47
	45	52
	46	58
	47	63
	48	69
	49	75
	50	81
	51	87
	52	94
54	42	32
	43	37
	44	42
	45	48
	46	53
	47	59
	48	64
	49	70
	50	76
	51	82
	52	88
	53	94
55	43	33
	44	38
	45	43
	46	49
	47	54

Dry Bulb	Wet Bulb	Rel. Hum.
55	48	59
	49	65
	50	70
	51	76
	52	82
	53	88
	54	94
56	44	34
	45	39
	46	44
	47	50
	48	55
	49	60
	50	65
	51	71
	52	77
	53	82
	54	88
	55	94
57	45	36
	46	40
	47	45
	48	50
	49	55
	50	61
	51	66
	52	71
	53	77
	54	83
	55	88
	56	94
58	46	37
	47	42
	48	46
	49	51
	50	56
	51	61
	52	67
	53	72
	54	78
	55	83
	56	89
	57	94
59	47	38
	48	43

Dry Bulb	Wet Bulb	Rel. Hum.
59	49	47
	50	52
	51	57
	52	62
	53	67
	54	72
	55	78
	56	83
	57	89
	58	94
60	48	39
	49	44
	50	48
	51	53
	52	58
	53	63
	54	68
	55	73
	56	78
	57	84
	58	89
	59	94
61	49	40
	50	44
	51	49
	52	54
	53	58
	54	63
	55	68
	56	73
	57	78
	58	84
	59	89
	60	94
62	50	41
	51	45
	52	50
	53	54
	54	59
	55	64
	56	69
	57	74
	58	79
	59	84
	60	89
	61	95

Dry Bulb	Wet Bulb	Rel. Hum.
63	51	42
	52	46
	53	51
	54	55
	55	60
	56	64
	57	69
	58	74
	59	79
	60	84
	61	89
	62	95
64	52	43
	53	47
	54	51
	55	56
	56	60
	57	65
	58	70
	59	74
	60	79
	61	85
	62	90
	63	95
65	53	44
	54	48
	55	52
	56	56
	57	61
	58	65
	59	70
	60	75
	61	80
	62	85
	63	90
	64	95
66	53	40
	54	45
	55	49
	56	53
	57	57
	58	61
	59	66
	60	71
	61	75
	62	80

HUMIDITY IN THE AIR OF CURING ROOM—Continued.

Dry Bulb	Wet Bulb	Rel. Hum.
66	63	85
	64	90
	65	95
67	54	41
	55	45
	56	49
	57	53
	58	58
	59	62
	60	66
	61	71
	62	76
	63	80
	64	85
	65	90
	66	94
68	55	42
	56	46
	57	50
	58	54
	59	58
	60	63
	61	67
	62	71
	63	76
	64	81
	65	85
	66	90
	67	95
69	56	43
	57	47
	58	51
	59	55
	60	59
	61	63
	62	67
	63	72
	64	76
	65	81
	66	86
	67	90
	68	95
70	57	44
	58	48
	59	52
	60	55
70	61	60
	62	64
	63	68
	64	72
	65	77
	66	81
	67	86
	68	90
	69	95
71	58	45
	59	48
	60	52
	61	56
	62	60
	63	64
	64	68
	65	72
	66	77
	67	81
	68	86
	69	91
	70	95
72	59	45
	60	49
	61	53
	62	57
	63	61
	64	65
	65	69
	66	73
	67	77
	68	82
	69	86
	70	91
	71	95
73	60	46
	61	50
	62	53
	63	57
	64	61
	65	65
	66	69
	67	73
	68	78
	69	82
	70	86
	71	91
	72	95
74	61	47
	62	50
	63	54
	64	58
	65	62
	66	66
	67	70
	68	74
	69	78
	70	82
	71	86
	72	91
	73	95
75	62	47
	63	51
	64	55
	65	58
	66	62
	67	66
	68	70
	69	74
	70	78
	71	82
	72	87
	73	91
	74	95
76	63	48
	64	52
	65	55
	66	59
	67	63
	68	66
	69	70
	70	74
	71	78
	72	82
	73	87
	74	91
	75	95
77	64	49
	65	52
	66	56
	67	60
	68	63
	69	67
77	70	71
	71	74
	72	78
	73	83
	74	87
	75	91
	76	95
78	65	49
	66	53
	67	56
	68	60
	69	63
	70	67
	71	71
	72	75
	73	79
	74	83
	75	87
	76	91
79	66	50
	67	53
	68	57
	69	60
	70	64
	71	68
	72	71
	73	75
	74	79
	75	83
	76	87
	77	91
80	66	47
	67	51
	68	54
	69	57
	70	61
	71	64
	72	68
	73	72
	74	75
	75	79
	76	83
	77	87
	78	92
	79	96

(137A) Curing Room Work. The curing process of softening and flavor development goes on inside of cheese, due to the curing agents (133), and is hastened or delayed by existing temperature and moisture conditions (134, 136), whether the cheese

is kept on the shelf or is packed for shipment. The press and curing room work is intended to develop a suitable rind on the cheese surface to protect the interior from damage, until it is cut.

To prevent the entrance of air through holes in the surface, and thus avoid the growth of mold inside the cheese, the conditions during the pressing or forming of American cheese, as to moisture content, temperature and pressure should be such as to unite the surface particles of curd into a continuous layer or rind, without any openings in the rind, although there may be many mechanical openings left inside the cheese. In many American cheese factories, the curing room work consists merely of turning the cheese over once or twice daily on to dry shelves so that the rind dries, becoming tougher and thicker, but not so dry as to crack, before it is paraffined and boxed for shipment. For this purpose, the curing room air should be low in humidity, 40 to 75%.

In the Limburger factory, the slight pressure applied to curd in the forms usually fails to close all surface openings, and the curing room work, (called smearing, greasing, rubbing, washing) is necessary to complete the rind formation, during the first two weeks or more. As any cheese dries, the rind shrinks and may easily crack, exposing the interior to infection with mold, etc. To permit drying all over evenly, the cheese are laid flat on the dry shelf, about two inches apart, and turned over daily (in a dry room) or every other day (in a verp moist room). The curing room air should preferably be at 90-95% humidity, for brick or Limburger to prevent too rapid drying and loss of weight. As soon as the exposed upper surface is no longer wet (in 24 or 48 hours on the shelf) the surface is moistened all over with weak (2%) salt brine, and replaced on a clean shelf, bottom side up. The moistening is done with both wet hands, rubbing the cheese, as one would rub a cake of soap between the hands. The rubbing of the young cheese rubs off the high spots and fills in the low spots of the surface, so that the rind after a week or two is continuous, and without openings, like the skin of a banana.

The rind is a layer of dried curd. As the drying proceeds, the rind gets thicker, but the surface never gets so dry as to crack, due to the repeated moistening and rubbing, every day or two. Recently, some makers have adopted the plan of using a hose to rinse freely the cheese as they stand on the shelf, before the hand smearing begins, thus to wash mold from the cheese and shelf.

When wet, the rind looks white, when drier it is brownish in color. When the rind is thick enough, the cheese is wrapped

and packed in boxes, thus leaving the shelves empty to receive more new cheese.

The handling of brick cheese in the curing room is about the same as above, but the brick cheese is often dipped in paraffine at about 220 degrees, before wrapping in paper.

The rind of the large sized Swiss cheese is developed by rubbing the exposed edge and top with weak brine, and turning over, every second day in a moist curing room.

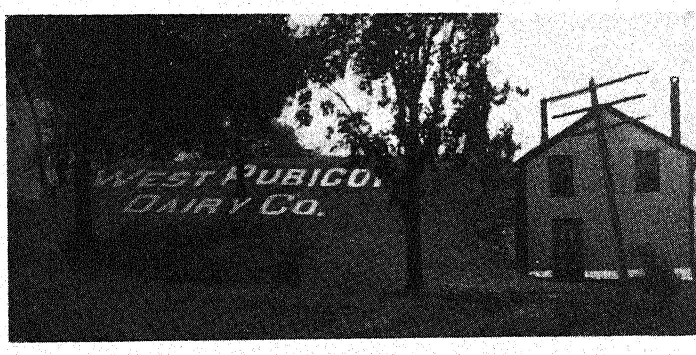
A curing trouble that may occur is the formation of very slimy, sticky layer on the surface of the cheese due to use of too much salt on the surface. The slime may be washed off in clear, warm water, and the cheese returned to a clean shelf.

(137B) Cave Curing Rooms. The cheese industry at Roquefort, France, owed its origin and success to the very large and unusual caves, where humidity and temperature remain practically unchanged throughout the year, and which came to be used as storage room for cheese made in that neighborhood from sheep milk.

In a similar way the caves in the Mendip hills, in the Cheddar valley, in southern England furnished curing room at constant temperature to the pioneer cheese makers of that country.

Caves in the bluffs along the Mississippi river, in Minnesota, Iowa, Illinois, etc., have more recently been used for curing cheese resembling Roquefort.

In southern Wisconsin, cheese makers dug cellars deep into hillsides, for cheese curing. In level country, a dug cellar has been walled up and roofed over with stone, and covered with earth and sod, often now with large trees growing above, and which today affords excellent cheese curing room, at the lowest possible cost, for maintenance. Cave conditions of temperature and humidity can be duplicated artificially in any warehouse. But this is rarely done, on account of expense.



Built-up Cheese Cellar.

CHAPTER XVIII.

Cleanliness In the Cheese Factory

(138) Suggestions. Keeping the cheese factory clean is the duty of the maker. In order to get ahead with any such important piece of work, it is necessary not only to perform the daily routine of cleaning but also to devote a little time each day to planning or putting into effect some improvements. Each day there is either a little more dirt collected in the factory, or the factory is cleaner than before, depending largely on the maker's attitude toward his work. No maker need have a dirty factory unless he is willing to do so.

Dirt is material in the wrong place. Thus, milk in the vat is milk, but milk on the floor or walls is dirt.

A good rule is to clean every utensil, immediately after using it, before it has time to dry, because it is easier to clean, and work does not accumulate when this is done.

(139) Steam Heat. Steam heat in the factory permits pasteurization of starter milk, insures a plentiful supply of scalding water for cleaning purposes, and enables the maker to comply with any law as to pasteurization of factory by-products fed to farm animals.

(140) Paint. As an influence in favor of cleanliness a fresh coat of paint in the intake or on the factory building is perhaps more powerful than any other one factor. With the building looking fresh and attractive, the appearance of the surrounding yard demands attention, and a weedy lawn, muddy drive, or pile of old tinware and vats begin to look offensive and out of place. Prizes offered for improvements in factory conditions have been a great help.

In a bright and freshly painted intake, what maker can work in a dirty pair of overalls, or fail to wash up spattered milk? The overalls can readily be scrubbed every night in a few minutes, rinsed and hung up on the line, thus always having a clean pair ready for the next day. If there is no better way at hand, soak them in hot soapsuds in a pail for a few minutes, spread them out on the floor, and brush thoroughly with the scrub brush. Rinse and hang up to dry.

A pair of gloves or mitts, kept at the boiler room door and put on when shoveling coal, will save much time and keep the hands clean. An outer apron, put on when shoveling coal, loading cheese, or doing any work outside of the make room, will help to keep the clothing clean.

(141) Odors, etc. Probably the most discouraging thing about some cheese factories in the past has been the foul odor from the decomposition of spilled whey. A cement block below the whey delivery pipe (89) will correct this, and enable the maker to admit a visitor to the factory without a feeling of shame at the odor. Flies should be kept out.

A shower bath of the simplest kind can be provided by enclosing a small corner, and erecting a shelf about six feet high on which to place a pail of warm water with a spigot, or both steam and cold water can be piped to a sprinkler placed overhead for daily use by the cheesemaker.

Cheese hoops can be quickly cleaned and freed from "milk stone" by dipping first in hot water, and then rubbing while hot with a brush dipped in a strong lye solution which will quickly loosen and remove the adhering material from the inside of the cheese hoop. Cheese hoops which are well tinned can also be left to soak in sour whey, over night, and then scrubbed.

Press cloths which become hard and stiff from dried whey, etc., are made soft and pliable again by soaking in sour whey or as some prefer, in a washing powder solution or in a pail of water containing a little sulphuric acid, after which they are washed and dried.

The floor, the outside as well as the inside of the vats, the intake walls, curing shelves, the whey tank, and the windows require regular attention and care, the same as all other parts of the factory and equipment, to keep them clean. The oiling of adjacent highways keeps dust out of the factory. The use of power fly sprays, electric fly screens at windows and doors, chlorine disinfectants, etc., are among recent improvements for keeping a factory clean.

An accumulation of junk in corners should not be permitted. Have a place for everything needed.

Many other suggestions on cleanliness will occur to the wide-awake cheesemaker or helper, and are given in publications of the Dairy and Food Commissioner relative to licenses for factories and makers.

"Toilet rooms shall be kept clean, in good repair and well ventilated. Durable, legible signs shall be posted conspicuously in each toilet room directing employees to wash their hands before returning to work. Convenient hand washing facilities shall be provided.

Rubber "squeegee" shall be used instead of broom in handling curd in the vat. (From "Minimum Requirements," Cheese Reporter, Sept. 26, 1941, p. 7.)

CHAPTER XIX.

The Food Value of Cheese

(142) "Eat More Cheese." This should be the housewife's motto, when she understands the facts. The ordinary "store" cheese, or American cheese, is well known for its attractive flavor, and it remains to make equally well known the facts (1) a pound of cheese has practically twice the food value of a pound of meat, and (2) that it is easily and completely digestible, without causing indigestion or constipation, when eaten in a reasonable proportion with other more bulky foods, as bread and fruits or vegetables.

(143) Cheese Costs Less. Cheese contains about 37% moisture, and no waste, while round steak contains about 8% bone, and other waste, and about 62% moisture, or altogether 70% of non-nutrient material. Steak contains about 9% fat and 19% protein, while cheese contains about 34% fat and 26% protein, etc.

(144) Easily Digested. In many households, where cheese is eaten freely as a substitute for meat, it is found that no ill effects follow its use. The Swiss nation are great cheese eaters. Few American mechanics or workmen of any sort do a harder days work than a Swiss cheesemaker, whose meals of cheese in large slices, bread, and vegetables are abundant, satisfying and wholesome in every respect. Experiments made in this country, in which large numbers of students were fed 1/3 pound of cheese with bread and bananas daily for three days, showed no indigestion or harmful effects in any case. One man who ate cheese as the chief source of protein and energy, eating an average of 9.27 ounces daily with bread and fruit for more than two years, did a fair amount of muscular work, and kept in good health.

(145) Cheese "Too Good." The principal complaint made by the housewife about cheese is that it is so good as to be all eaten up too soon, thus appearing to cost more than meat, but when it is considered that the food value of cheese is twice as great per pound as of meat, and that the appetite of a normal person commonly indicates what the system needs, the importance of a daily supply of cheese on the table becomes evident. The flavor, the economy and the digestibility are all in its favor.

(146) Human Food Standards. A man who does more or less work in lifting, and who walks about a good deal, such as a

salesman, would be likely to get the food which his body needs if supplied daily with such a combination of foods as:

1¼ pounds of bread or other similar food made of grains.

2 ounces or ¼ cup of butter, oil, meat drippings, etc.

1¼ lbs. of fresh fruits, and green vegetables or roots.

2 ounces of sugar, or 1/3 cup of syrup, honey, etc.

12 ounces of protein-foods, as cheese, meat, fish, eggs dried beans or in place of these, about three pints of milk.

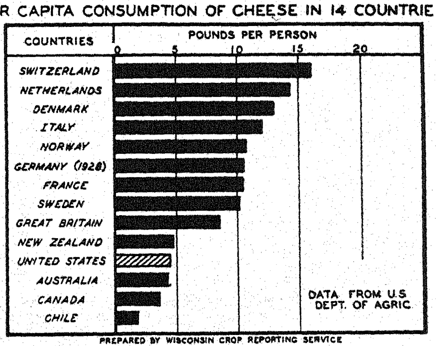
The ordinary full cream cheese contains both the required protein and the required fat, as shown above. A pound of cottage cheese supplies all the protein needed by a man in a day, but contains little or no fat. A quart of milk contains as much protein as 6 ounces of round steak or 4 1/3 eggs, and as much energy as 12 ounces of steak or 8½ eggs. With milk at 10 cents a quart it is cheaper than steak at 23 cents a pound, or eggs at 25 cents a dozen. Cheese contains butterfat and carries vitamins.

PER CAPITA CONSUMPTION OF CHEESE PER YEAR
U.S. Dept. of Agric., Handbook, 1933, etc.

Country	Year	Cheese Consumed pounds	Country	Year		Cheese Consumed pounds
Switzerland	1930	16.1	Czechoslovakia	1928		4.9
Netherlands	1930	14.3	New Zealand	1930		4.8
Denmark	1931	13.06	Australia	1930		4.3
Italy	1928	12.1	Union of S. Africa	1927	(1)	4.0
Norway	1929	10.77	Argentina	1930		4.0
Germany	1928	10.6	Austria	1930		3.78
France	1931	10.5	Canada	1930		3.7
Sweden	1929	10.2	Chile	1927		1.8
Great Britain	1930	8.52	Finland	1931	(2)	1.23
United States	1935	5.24				

(1) White people only. (2) Factory product only.

PER CAPITA CONSUMPTION OF CHEESE IN 14 COUNTRIES



PART II.

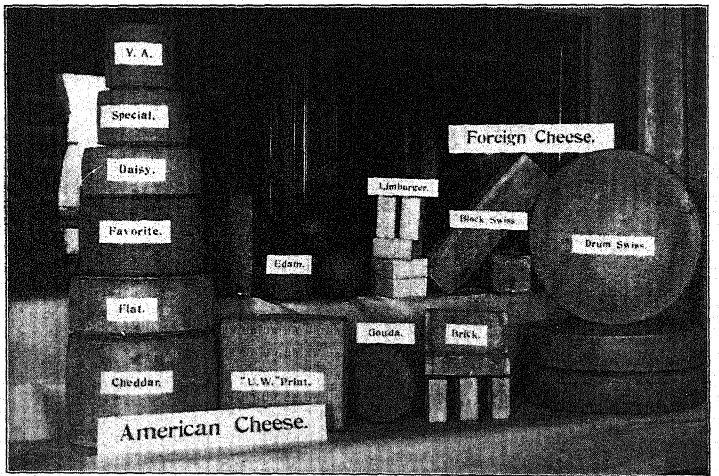
CHEESE VARIETIES, THEIR CLASSIFICATION AND MANUFACTURE

CHAPTER XX.

Cheese Varieties, Classification, Comparison

(150) Anyone visiting a large city market for the first time is surprised at the great number of different kinds, flavors, qualities, shapes, and sizes of cheese which are made from milk.

The student should take every opportunity to learn to recognize different kinds of cheese by name, flavor and appearance,



Over 30 varieties and styles of cheese are manufactured in Wisconsin.

to learn where each kind of cheese originated and where it is now manufactured. A helpful method, with a class of students at the close of the course of study, is to procure as large an assortment of cheese varieties, in small samples, as can be obtained with the aid of distributors' price lists, and to hold a "cheese party." This will afford each student sufficient time to inspect, compare, and taste the samples in a leisurely manner, to weigh and measure the packages, and write notes upon each variety.

For reading and study, students may obtain for 10 cents from the Supt. of Documents, Washington, D.C., a copy of the 1928 revised Bulletin 608, U. S. Dept. of Agriculture, "Varieties of Cheese" containing names, brief descriptions and analyses of nearly 250 varieties from different parts of the world. A useful exercise may consist of dividing these varieties in groups and classes so far as possible and finally counting the number of kinds of cheese in each group. (Geneva, N. Y. Circ. 87). Advanced students should study "Fundamentals of Dairy Science," by Associates of Rogers. Other sources may also be consulted.

(151) Similarity of Different Cheese. Frequently the same kind of cheese as to method of manufacture, is put up in a variety of different sized packages, called by different names. Thus American Cheddar cheese is called according to the size and shape of the package, Young America, Daisy, Flat, Long Horn, square, mammoth, Cheddar, midget, etc. Swiss cheese is made either as "block," an oblong shape and weighing about 20-30 lbs., or as "drum," a round cartwheel shape and weighing 100 to 200 lbs. each.

It frequently occurs that different names are given to cheese made in different localities or by different firms, although made by exactly the same process, and alike in size and in all essential respects except the label or brand.

To show the similarity of all cheesemaking processes and the differences in procedure by which the many varieties of cheese are produced from milk, the following list of operations and conditions has been prepared. In making any specific kind of cheese, one part or another of the general process as here outlined may be entirely omitted while other parts receive special attention in order to produce the desired kind of product.

A. (1) Material Used. Milk of the cow, or sometimes the sheep, goat, or rarely of other animals.

(2) Richness. Whole milk, part skim, full skim milk, or rarely enriched milk or cream.

(3) Ripeness. Sweet, fresh and warm from the animal; nights and mornings milk mixed together; ripened to .18%; to .25%; to .30% acidity or above.

(4) Cleanliness. In general milk should be clean and free from putrefactive germs; but with ripened milk great care is not so necessary as with certain cheese varieties made exclusively from fresh, sweet milk, such as Limburger or Swiss. Milk is always strained at the factory when received; and sometimes clarified, or pasteurized.

B. Inspection. This should always be done in order that the maker may know what he has to work with. Defective milk is thus stopped at the intake.

C. Testing in the Vat. Standardization, if desired. With cheese made from ripened milk, the ripeness or acidity of mixed milk in the vat is usually tested as early as possible, and repeatedly afterwards.

D. Heating up the Vat. Milk is heated to a suitable temperature which may be 72, 86, 90 or 96 degrees, for different sorts of cheese.

E. Ripening. The warmed milk, either with or without the addition of starter, may be held in the vat for a time to attain the required degree of acidity, or this may be omitted.

F. Thickening. In most cases thickening is produced by the addition of rennet extract, or pepsin, or very rarely by certain plant juices, and in a number of cases by souring the milk, as with cottage cheese.

G. Cutting the Curd. This is done with a variety of tools, such as knives, wire strung harps or in the case of skim milk by stirring with a rake.

H. Stirring the Curd. To prevent the cut or broken particles of curd from uniting to form lumps or large masses, stirring may be done by hand, by mechanical agitators, or various tools.

I. Firming the Curd. The separation of the thickened milk into curd and whey begins (after cutting) rapidly at first, then more slowly, making the curd firmer as it proceeds.

J. Heating the Curd. To hasten the separation of whey from curd, the vat may be heated, if necessary, to a higher temperature, as 96, 100, 110, 120 or 130 degrees or thereabouts or heating may be omitted here. A slight pressure on the curd may also aid in whey separation.

K. Draining the Whey Off. The curd is freed from the separated whey, either by dipping up the curd in a cloth bag, through which the whey drains, or by drawing or siphoning the whey out of the vat, leaving the curd behind. The firmness or acidity of curd, or acidity of whey may be tested at this point.

L. Matting and Milling Curd. If the drained curd is allowed to lie quiet in the vat, to mat or unite into a single large mass and develop acid, it is afterward cut up or milled into small pieces again. Both matting and milling may be omitted and the granular process used.

M. Salting Curd. The addition of salt, and sometimes other flavors, by stirring them well with the curd particles after either (K) or (L) is sometimes included and with some cheese varieties is omitted at this point.

N. Forming Cheese. Curd may be placed in hoops of the proper shape and size after (K), or (M) or directly after (G) or (F).

O. Ripening Mould germs are sprinkled on the surface or inside of curd in the hoops, in the case of a few cheese varieties, to aid in the curing process.

R. Pressing Cheese. Pressing expels the loose remaining whey and compacts the curd particles into a solid mass, usually of the required shape for market.

S. Salting Cheese. Some cheese are salted at this point by placing in strong salt brine, or by rubbing dry salt on the surface.

T. Curing. Placed in curing rooms of proper humidity and temperature, cheese undergo changes in flavor and texture necessary for marketing.

U. Care. While in the curing room, cheese require more or less attention and care as washing, cleaning, turning, together with salting and paraffining when required, and finally packing for sale. Some kinds of cheese require wrapping, grating, drying, staining, varnishing, etc.

(153) Complexity of the Work. Although these details can be thus listed, one after another, it should not be supposed that each step can be carried to completion independently of the others. Thus, the coagulation by rennet is not fully completed, but only to a medium degree at the time the curd is cut. The separation of whey which begins at cutting is not fully completed, but only up to a definite stage when the next step is begun. The temperature used when thickening the milk not only hastens or delays that process, but also hastens or delays the separation of moisture from curd after cutting. The temperature to which a curd is afterward heated or "cooked" or "burnt" not only hastens whey separation, but also may affect the bacterial content and growth in the finished cheese, or often promoting or preventing a gassy texture. The acidity of milk used or the proportion of starter added may hasten the coagulation, hasten the whey separation, check gas formation in cheese, and if excessive may produce a sour, acid cheese, of inferior value, off flavor, and short crumbly texture. The curing process is begun in the vat and a few hours extra time in the warm vat may advance the curing as much as several days in the curing room. Thus several essential changes may be in progress at one time. (Read chapter 29.) It is necessary to learn the effect of each part of the work on all that follows, and to watch the whole process daily.

(153A) The Cheesemaker's Judgment. With the aid of thermometer, acidimeter, and by the senses of sight, smell and feeling, the cheesemaker is able to follow and often control the progress of the curd through the manufacturing process. Since American cheese is the most important, details which apply to all kinds of cheese are explained most fully in chapter XXIX. Sec-

tions 261 to 267 should be fully understood by makers of any kind of cheese. Several stages in the "firming" of the curd, or in the separation of whey from curd can be distinguished by the experienced maker.

First. A handful of curd taken from the vat without pressure from the fingers, soon after cutting, quickly settles into a compact mass, all of the cubes losing their shape and sticking together. The whole mass quakes like jelly when shaken slightly, and whey drainage from the mass soon stops. This can be observed repeatedly at short intervals of time and in making Limburger cheese, the curd is dipped just before this condition is lost.

Second. If left longer in the whey the curd cubes become somewhat firmer, so that when a handful is picked up, the cubes settle together only slightly, leaving the mass somewhat porous, and the curd in the hand drains fairly well because it is somewhat open and loose. In making brick cheese, the curd is dipped in this condition.

Third. If left longer in the whey, the curd cubes become firmer as time passes, so that a handful of cubes taken out of the whey show very little tendency to stick together, but fall apart readily when shaken slightly. At this stage, a slight pressure upon the mass between the hands may unite the cubes if softer, or may have little or no effect so that the curd pieces spring apart readily when shaken. A very firm curd can be pressed together into a compact mass by a definite pressure for several seconds in the hands but the cubes will easily shake apart. These tests apply to American cheese.

Fourth. Continued heating at high temperature in the Swiss cheese kettle makes the curd drier, so that after pressing a handful firmly together for a half minute, the mass is "short" and breaks in two readily when any attempt is made to bend it, showing the cubes to be only very slightly united, although firmly pressed in the hand. These and similar tests are used by the experienced maker (212).

Fifth. In some cases, as with cottage cheese, it is easier to judge its condition, if a handful of the hot curd be cooled in cold water a half minute, and then examined.

Regulating Both Firmness and Acidity. In making any particular kind of cheese, the curd is brought to the required degree of firmness, just before the whey is drawn off, or the curd dipped out of the whey. The acidity of the whey should not exceed a certain figure, at the time the curd is firm, just before the whey is drawn off. For example, this might be .11% acidity for Limburger, or .17 to .19% for American Cheddar.

(154) Plan of Study. The cheese making process may be studied in the following chapters, beginning with the simplest forms, as in making casein, cottage cheese, and its derivatives, followed by junket, Neufchatel, Coulommier, Camembert, Brie, Limburger, brick, Swiss, Edam, Gouda, cheddar, caccio cavallo and other kinds. By this system, the simplest processes are used first, making soft cheese and the additional details added later for making hard cheese are more easily understood by the student. (See Preface.)

(154A) Small Scale Experiments for Classroom Practice. In order that all students in a class may have the advantage of doing the work, each with his own hands, it will often be found helpful and satisfactory to have each student first carry on the entire process with 10 or 20 pounds of whole milk, skim milk, etc., carefully weighed in a pail. With such small quantities, heat can be applied by placing the pail for a few minutes in a tank of warm water and the final products thus obtained should be exactly weighed to determine the yield and examined and compared to determine the quality, and especially to notice the effect of intentional or accidental variations of the method.

For example, with a class in casein making, different students may follow the same methods in all respects, except that each may heat the material to a different final temperature, or for various periods of time, with or without subsequent cooling with cold water, and the effect upon the product observed by all present. Many such experiments can be devised, in which each member of a class can take part with benefit to all.

From the records as to materials and time used and yields obtained, students should usually make calculations as to the costs of manufacture and the profits to be obtained by each method. It is usually advisable to allow or require students to repeat the manufacture of a given product, on different days if necessary, and finally with a larger quantity of material, to ensure that a reasonable degree of familiarity and certainty is attained in handling the process on a large scale and to fix the details firmly in the mind.

The student's notebook should be written up at the time of doing the work, giving complete details, so that by reading the record after several months have passed the student may have no difficulty in making the same product with success.

The making of casein is especially well suited to serve as an introduction to the making of cheese, since it affords experience in the handling of skim milk in the simplest possible way and there is no danger of spoiling the product so that it can not be utilized, which might easily happen to the beginner undertaking to study first a more complicated process.

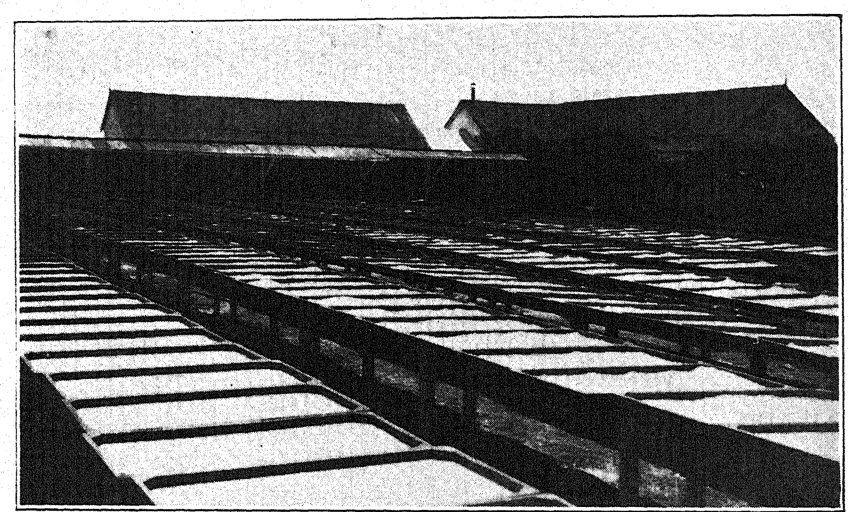
CHAPTER XXI.

The Making of Casein

At times, depending on market prices offered, a number of factories have found casein and cream or buttermaking more profitable than cheese.

(155) Casein making begins by curdling skim milk with sulphuric or muriatic acid, or rennet, or by self souring. After most of the whey is expelled, the curd is washed, drained and may be pressed, shredded and dried, and milled or not at the factory. Large plants carry on the entire process, but small plants often ship wet casein in cold weather or cooked casein in warm weather to a near-by drier.

The process used depends mainly on the use to be made of the casein. Cooked casein is used quite exclusively for glue mak-



Drying Casein in Open Air, in South America.

ing. Rennet casein is made occasionally and is used mainly for making plastics, buttons, etc. (N. Y. (Geneva) Tech. Bul. So. 230.) Muriatic acid casein is seldom made unless the whey is to be used for making milk sugar, as the casein yield is apt to be lower when using this acid. Sulphuric acid casein can be used for making glue. Self soured casein is preferred by many firms for paper coating. In any case the maker should get the buyer's

advice as to method of manufacture preferred. Milk does not always "work" the same, for unknown reasons, and processes may vary. The heat and acidity in casein making is hard on a tin vat. Vats may be made of redwood, boiler iron, or of stainless steel, or a used cheese vat can be employed.

A practical method of preventing foam consists in arranging the receiving can so that the effluent from the separator strikes the side of the receiving can at a small angle so as to run down the metal side, thus carrying into the liquid the smallest possible quantity of air bubbles. Or, use a foamless separator.

To avoid foam in the vat, the skim milk is often run from the separator into a receiving can and the liquid without foam drawn from the bottom of the latter into the casein vat. In the vat, foam may be removed from the surface of milk with a lath. At 68-86 F., less foam is produced in the separator than at other temperatures. (U. S. Dept. Agric. Circ. 108; Circ. 279.)

Skim milk for casein making should always be as free from fat as possible Most buyers insist that curd must be thoroughly washed in the vat during manufacture. (Mich. Tech. Bul. 82.)

(155A) The Choice of a Method. A quick method of curdling milk and getting it into the press is by the use of rennet, if the buyer wants this kind of casein. Curdling fresh skim milk with sulphuric or muriatic acid is also rapid. The older self souring methods require from two to six hours delay until the acidity develops high enough for curdling, so that the work is finished during the afternoon. A rapid, continuous, curdling process has been devised lately. Self souring methods avoid the cost of acids or rennet extract, but use sour milk or whey. The method of coagulation preferred by the buyer should be used, who will usually furnish directions and blue prints.

(155B) Self Soured Casein, Not Pressed. For shipment to a nearby drier in cool weather, casein is made in some factories as follows: Add to the separator skim milk in the vat, while stirring well, enough sour whey (2. to 10.%) to cause coagulation in 3 to 6 hours, but not curdle the milk during the addition. Heat to 100 degrees (never over 108) and leave quiet. To know when the vat has enough acid for coagulation, make tests in a dipper with a little milk. Place the dipper on hot water, and stir with a thermometer until it curdles. When the milk in the test forms curd and whey at about 135 degrees, the vat is ready to heat immediately. Run live steam into the milk and stir rapidly to secure even heating. When the curd separates, allow it to settle, draw off the whey, and fork the mass of curd into large piles on each side of the vat. As these piles spread rapidly, turn and fold them with the fork two or three times while draining

and washing with a hose. Finally throw the chunks of curd into a clean washed barrel, having a few holes bored in the sides to permit continued drainage.

By the next day, this curd has cooled and hardened so that it will not fall out of the barrel when tipped over. It should tear in long shreds or sheets, but not crumble in the fingers, as it will do if too much acid was developed before heating in the vat, so that it curdles at temperature in the vat below 120-130 degrees.

A batch of casein from milk which has ripened so far as to curdle at 100 degrees in the vat is likely to be inferior in quality and should be kept separate.

While draining curd, a burlap sack tied over the vat gate will prevent loss of small curd particles.

By the method described above, the casein is barreled and shipped without pressing, and without thorough washing.

(155C) Self Soured Casein, Pressed. This process begins the same as in (155B), but the curd is made firmer in the vat, and is broken up in the cold wash water so as to wash and cool all parts of the curd. It is then shoveled into the press forms, cold, and pressed until it stops dripping, in one to three hours. It is much cheaper to remove moisture from curd in the vat or press than to do it later in the drier. This curd is then run through the shredder. It may then be spread on trays in the drier, or filled into barrels, covered with burlaps held in place by the top hoop and shipped in cool weather to a nearby drier. The advantage of drying immediately at the factory comes from the lower cost of shipment after drying, and the fact that the maker knows exactly how many pounds of dry casein he should be paid for, when sold.

Continuous Process. The above described methods require several hours time to ripen the milk to the right acidity for curdling. To avoid this delay, a method for continuous curdling has been used recently at a few factories. The skim milk runs down from a tank above through a hand valve, and a three inch pipe with a tee at the bottom. Attached to one side of the tee, a steam jet shoots 2-day old sour whey, from a tank above, into the stream of skim milk which is instantly curdled. The curd and whey run out of the opposite side of the tee, through a crooked pipe, into the cheese vat below. When the vat is full of curd and whey at about 120 degrees, the curd settles and the whey is drawn off. The curd is rinsed, and then pressed over night. It is then milled, washed thoroughly, pressed again, put through a one-half inch screen, spread on 3/16 inch drying screens, left in a 40 foot drying tunnel for 6 to 12 hours, and packed. U. S. D. A. Circ. 279.

(155D) Sulphuric Acid Casein, Pressed and Dried. In this process too much acid or too high acidity is to be avoided. The skim milk, as sweet as possible, is run into the vat, and foam removed from the surface. In a wooden bucket, place about three volumes of water, and stir in one volume of sulphuric acid, stirring well to mix. Use about 1 pint of acid for each thousand pounds of milk in the vat. Heat the milk to 116 or 114 degrees. Stir the milk briskly with a rake, while another man pours in the diluted acid slowly from a pitcher, distributing it evenly up and down the vat. Stir without interruption. As soon as the curd separates, leaving clear, greenish (not milky) whey, no more acid should be added. Stir well, drain, wash well, and press the curd cold as described in (155C). If too warm the curd tends to collect in a doughy mass. If too little acid is used, the whey is milky, and the curd tends to gather in a doughy mass. With a little more acid, the whey is clear and greenish, and the curd does not gather in a doughy mass, but remains in lumps smaller than an egg, and can be washed easily and drained without loss. If too much acid is used, the curd is very fine grained, and hard to drain, and should be put on a cloth covered draining rack for a few hours, before pressing.

(155E) Sulphuric Acid Cooked Casein. By this process the curd is not pressed or dried at the factory, but is made into a tough doughy mass, in the vat and shipped in barrels to the drying plant. For this purpose the skim milk is heated to 120 (not over 122) degrees.

In curdling the milk with dilute sulphuric acid, only half of the calculated amount of acid should be added at first. The milk is then stirred well for several minutes. If curdling does not begin, add a little more of the dilute acid, and continue stirring. No more acid should be used than enough to produce a milky (not clear, green) whey. When this point is reached, push the curd to the low end of the vat, drain off the whey, cover the curd with cold or warm water, break up the curd well with the fork or rake to secure thorough washing, and finally run direct steam into the third wash water to heat it to 180 degrees. At this temperature the curd will melt together into a mass with the consistency of soft bread dough. Draw off the water. Work and knead the curd well to remove the remaining water. Transfer the doughy curd to a clean barrel while hot, and when cold cover with burlap over the top of the barrel, held in place by the top hoop. The use of too much acid in curdling makes it hard to gather the curd into a doughy mass. The wet "cooked curd" shipped in barrels from the creamery reaches the buyer in a solid lump, the surface of which is dry and tough, and free

from openings, so that no mould can grow into the mass during shipment. It must be shredded before drying. (156)

(155F) Grain Curd Casein. Some large firms use this process in which the acidity is carefully controlled. See U. S. Dept. of Agric. bulletins.

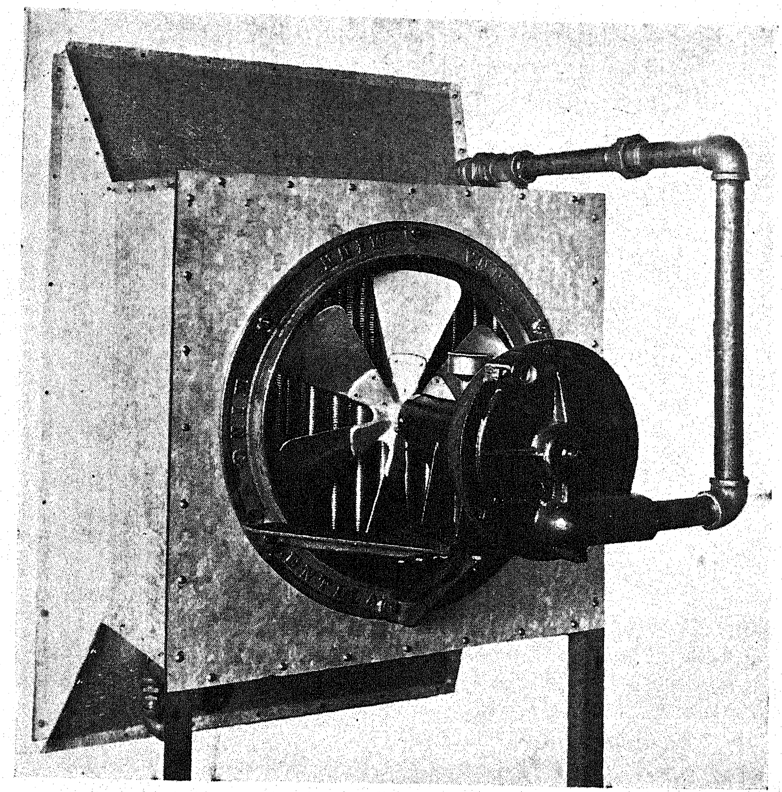
Heating is sometimes done by running the curdled milk through a steam jet or ejector. U. S. Dept. Agr. Bul. 661.

(155G) Rennet Casein. To the vat of skim milk at 95-100 degrees, stir in 1 or 2 ounces of rennet extract per thousand pounds, and keep on stirring briskly until the curd separates. Settle and drain off the whey, cover with cold water, stir, drain, press, and dry.

Made from sweet skim milk, this curd is very easy to handle. In the whey, the curd settles in coarse grains, does not form lumps, and after pressing, the curd is easily broken up by hand to be spread in the drier. If the milk is somewhat sour, it tends to be lumpy in the whey, (unless set at a lower temperature) and to form a solid cake in the press, so as to require to be run through a mill or shredder before drying. This is a rapid method to make rennet casein.

It is, of course, possible also to set a vat of skim milk with rennet at 90 degrees F., cut the curd with knives, stir and heat either to 115-120 degrees, or to 135 degrees, stirring to avoid formation of lumps in the whey. The curd is drained, cooled and washed with cold water, pressed, milled, and dried. (Mich. Tech. Bul. 82.)

(156) Making "Dry Casein" from "Wet Curd." The "wet curd" from the press or shipped in barrels from the creamery is run through a power mill, or "green curd shredder" which cuts it up fine. The ground curd is spread in thin layers on trays 30 inches square. These trays consist of a frame made of wooden strips 1 inch square, to which is tacked a square of ¼ inch or 3/16 wire netting of galvanized iron. The curd is spread and struck off with a straight edge, about ¼ inch to ½ inch thick on the trays, which are then piled 4 or 5 feet high, on a square truck having four castors at the corners. The truck loads of curd are wheeled into the cool end of a long drying kiln or tunnel, built of matched lumber about 4 feet high and 32 inches wide inside to hold a row of trucks, and 10 to 40 feet long. A fan blows a regulated stream of air through a steam radiator and then across the casein on the trucks. After partial drying the trucks are pushed forward toward the warmer end and after 6 to 12 hours when the casein is bone dry they are taken out and emptied. A moisture test shows about 5% of moisture. Too high

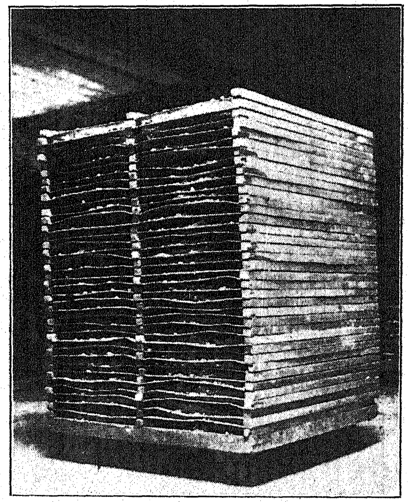


Fan, motor and steam coil for drying casein.

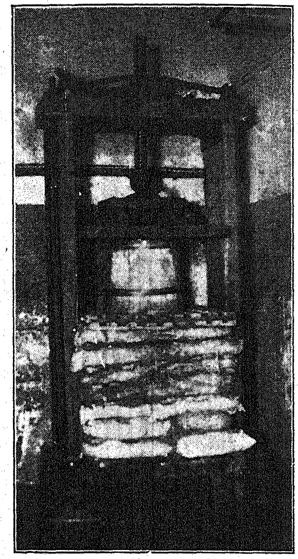
or low drying temperature causes abnormal color which should be white or straw color. By control of air speed and volume, and of temperature between 125 and 135 F., drying is finished in 6 to 8 hours. U.S.D.A. Circ. 279.

The student can grind the casein in a food chopper from 10-pound lots of milk and dry it in the air in a week, or more rapidly on square wire netting shelves in a small oven with open bottom, set over a steam coil Any creamery wishing to make either wet or dry casein for sale can usually obtain from the buyer full directions for making and drying the product and for building the drying equipment.

(157) Pressing Casein for Drying Before Shipment. Where it is intended to dry the wet casein at the creamery before shipment, the final heating is not above 135 degrees, so that the curd remains in somewhat loose, granular mass, sticking together slightly, to avoid loss of small particles. After washing in cold



Drying trays on a wheeled truck permit the rapid drying of casein in large quantities, in a current of warm air.



A vertical press is used to remove the loose moisture from casein before drying in the kiln.

water the curd is drained well and packed in press cloths in a square frame six inches deep or in bags, such as grain sacks, which are then tied.

The bags or cloths full of curd are packed in layers in a vertical press, with 30-inch square wooden slat frames between the layers. The screw press is then tightened gradually to keep the whey running, until the dripping stops. The curd is then emptied out of the bags, and is easily ground up and afterward spread on the drying frames and dried in the tunnel as described in (156). The student can follow this process with 10 or 20 lbs. of skim milk in a pail.

(158) Making Glue Out of Casein. Curdle a few pounds of skim milk at 130 degrees with a little sulphuric acid, while stirring well. Settle, and pour off the whey, wash the curd once with warm water, strain it on cheese cloth, and press the bag of curd as dry as possible in the hands, for a few minutes. Part of this curd, rubbed up fine, may be dried over a steam coil and stored in a bottle for future use. Whenever needed for making glue, the dry casein may be soaked for a short time in warm water, drained, and treated as follows:

Dissolve a very little concentrated lye, or caustic alkali, in 3 or 4 times its bulk of water. Stir in the fresh moist casein, or the soaked casein, rubbing the mixture with a spoon, or pestle, to

dissolve as much casein as possible. The resulting mixture is a good glue, and is often used to glue cloths to large Swiss cheese to prevent them from bursting. Similar preparations made with various added chemicals and with lime instead of lye are used as furniture glue, waterproof glue, etc., for commercial purposes.

Another recipe calls for 10 oz. curd, 4 oz. water and, 2 oz. slaked lime. See Casein Glues: Their Manufacture and Application. Forest Products Laboratory, U. S. Dept. of Agric., at Madison, Wis., Revised Edition.

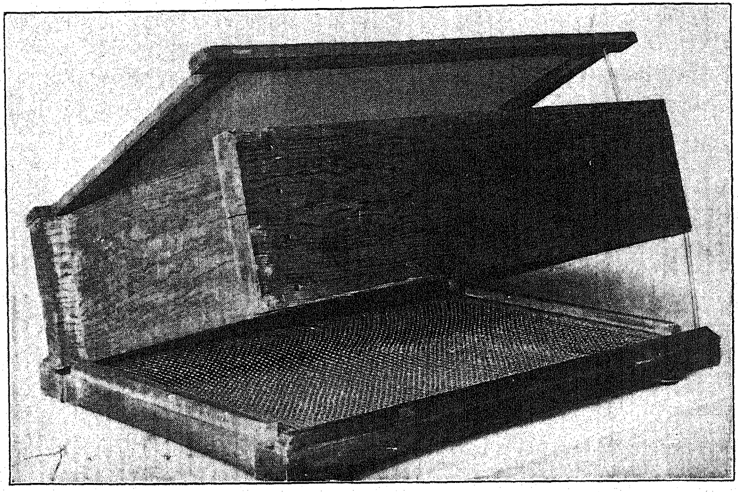
With a straight edge, spread some of the glue evenly in a thin layer on the surface of some unglazed paper and leave to dry, and note the glazed surface. Casein ground to 60 mesh size, and mixed with borax or slaked lime, water and with resin soap and some minerals, is used for glazing paper.

Casein dissolves readily in any alkali and has many commercial uses.

(159B) Milk Sugar from Whey. In a few localities where very large amounts of sweet whey are available daily, the manufacture of milk sugar has been undertaken. Vacuum pans, filter presses and other special machinery are used. The uses and demand for milk sugar are limited to medicines, special foods, etc. Its food value is equal to that of cane sugar, but its sweetness is much less. Milk sugar is easily extracted from whey powder. (Nat. B. and C. Jrnl., June, 1939, p. 63.)

(160) Buttermilk for Casein Making. Casein made from buttermilk is inferior in glue-making qualities, so that if more than 10% of buttermilk is mixed with skim milk, the resulting casein is likely to sell at a reduced price. The yield of dry casein from 100 lbs. of buttermilk is about 2¼ lbs. as compared with 3 to 3½ lbs. or more obtained from 100 pounds of skim milk. Buttermilk, if used, must not be coagulated previous to mixing with the skim milk. Some buyers refuse buttermilk casein at any price. To make casein from raw cream buttermilk, or from sweet-pasteurized cream buttermilk, where the cream was soured after pasteurizing, the buttermilk is heated in a vat by running steam into the vat jacket, stirring the buttermilk until the temperature reaches 130-140 degrees. The heating is sometimes done by running the buttermilk through a steam jet or ejector. (U. S. Dept. Agric. Bul. 661.) Then let the material stand quiet without stirring for about an hour, during which time the curd rises to the top of the whey in a compact layer. If it settles to the bottom this shows that the cream was more or less sour when pasteurized (161). In either case, after an hour, the whey can be drawn off quite completely leaving the curd in the vat, by carefully opening the gate part way at first, so as not to

disturb the curd by the whey currents. The curd rack and cloth below the gate catch any curd which escapes, and the whey,



The flat draining rack with bottom of half-inch wire netting can be made large or small, as required, but is always about one foot deep, and is covered with cheese cloth for draining cottage cheese and similar materials.

flowing out, passes through the cloth into the drain. Finally, the curd in the vat runs or is scooped out upon the cloth, and left to drain for about 24 hours. It is not possible to get buttermilk curd to unite into a plastic doughy mass, as does skim milk curd at 190 degrees, but the granular buttermilk curd after draining fully is packed into barrels for shipment, or may be dried at once, in the drying tunnel. For white curd or buttermilk cheese, see (172D). Wis. Bul. 315 (1920)

(161) Making Casein from Sour Pasteurized Cream Buttermilk. With this kind of buttermilk it is almost impossible to get a curd which can be collected on a cloth, or drained in a reasonable time, as the curd obtained by heating is very fine grained, like chalk dust and always settles very slowly after heating. If a mixture of 1 part skim milk and 4 parts or less of this buttermilk is heated to 130 degrees, the skim milk curd collects and encloses the buttermilk curd, and the mass can be caught and drained rapidly on a cloth without loss.

(161A) Casein or Dry Powder from Skim Milk. The well trained, experienced cheesemaker may find, at times, a larger profit from the sale of sweet cream and either casein or skim milk powder, than from the sale of cheese. Several small sizes

of cylinder type, skim milk powder machines are on the market for occasional or continuous use in cheese factories. The ability to take advantage of favorable prices for skim milk powder, casein, sweet cream, etc., adds to the profits of the factory, and the knowledge of methods for making these additional products affords to cheesemakers access to more responsible positions, in larger factories, at better pay.

(161B) The making of plastics from casein and other materials is described in U. S. D. A. Tech. Bul. 230 (1935).

CHAPTER XXII

Cottage Cheese

(162) Cottage Cheese from Sour Skim Milk. A recent bulletin describes the home process as follows: Put clean, fresh skim milk in large container. Add a little sour milk or starter, about 1 cupful to a gallon of milk to hasten the curdling. With a good starter, the skim milk will curdle in about 10 to 15 hours at a temperature of 75° F.

When the milk is firmly clabbered, pour into it about one-third as much boiling water as you have milk, or enough boiling water to heat the mixture to about 100° F. to 110° F. Carefully stir the curd and let stand seven to ten minutes or until the curd has barely separated from the whey. Pour the whole mixture into a cheesecloth strainer or a fine wire strainer and let drain. If you prefer a mild flavored cheese, pour cold water over the curd. This washes it and removes the acid flavor. Salt the cheese to suit the taste. The cheese should be smooth and creamy. If the curd is tough or grainy it may have been caused either by keeping the milk at too high a temperature or by allowing it to stand too long a time at a high temperature. A thermometer is an excellent aid. (Farmers Bul. 1451.) (Col. Circ. 48)

In a busy creamery, the method is modified so as to permit the cheese to be made with the least labor and time, at a time of day convenient for the operator, and so as to get the vat empty in time to receive the next days milk. (U. S. Dept. Agric. Bul. 576.)

In the factory, skim milk is run from the separator into a vat or any receptacle which can be heated. A regular cheese vat is preferable, and a tall, cylindrical strainer to fit inside the vat next to the outlet should be purchased with the vat.

Although not so convenient, it is possible to use a vat without a jacket, heating the curdled milk to 105-110 by adding boiling water, while stirring with a wooden rake. The older method of souring skim milk in milk cans, heating each can by placing it in a tub of hot water, is yet more inconvenient where a large quantity is handled. For student's exercise, 10 pound portions of skim milk may be weighed into tin pails, and left to sour. From 2 to 10% of starter may be used.

(163) Finishing the Cheese. When the milk is thick and the maker is ready, the curd may be cut into cubes with ordinary cheesemakers' curd knives, having blades ½ to 1 inch apart to avoid too fine cutting. Many makers prefer instead to use a

wooden rake, which is moved slowly back and forth through the curd to break it into rather coarse flakes, but not beat it to a smooth pulp or into fine grains. (Students may stir curd in a pail slowly with a thermometer, as the hand or a dipper will break it up too fine.)

While stirring (after cutting with knives, if used) the steam is turned into the jacket, and the material heated to about 105 degrees, or if preferred (168) using higher temperatures. When at the selected temperature the curd is stirred occasionally until judged to be firm enough for the next step. This often requires several hours.

The whey is drawn off, the curd is washed, cooled and drained, and finally salted and packed for sale. The details may be varied considerably.

(164) The Quickest Way. A Wisconsin bulletin directs to drain the curd and salt it in the vat in which it is made, thus saving floor space which a draining rack would require, and also shortening the time and labor required.

As soon as possible after separating the milk, add 5, 10, or 20% starter and heat to 100 degrees, so that it will sour and thicken during the same afternoon. Acidity is about .5%. As soon as thick, cut two or three ways with curd knife wires ½ to ¾ inch apart. While stirring gently with the rake, teeth down, heat immediately, so as to raise the temperature about one degree a minute. Stir gently to keep from forming lumps, but not break the curd into fine grains.

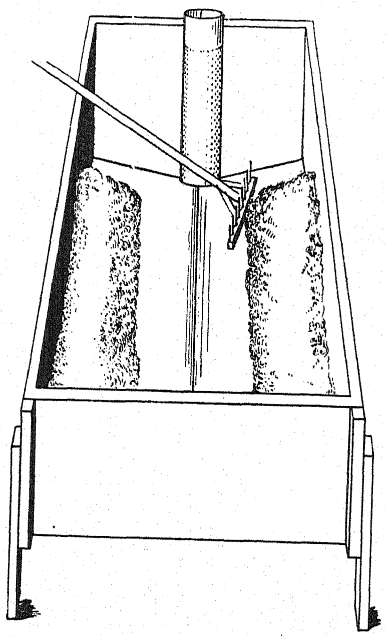
The heat is most easily applied by running steam into the jacket, full of water or empty, while stirring steadily, but some makers prefer to heat by pouring hot water on the curd, and stirring it in, with more hot water every five minutes. Within half an hour, the final temperature is reached, never over 135.

The heating and stirring is continued until the curd is seen to be "firm enough," which may occur at 110, 120, or 130 degrees at different times of year. The firmness of the curd can be judged best by taking up a handful of curd, without squeezing it, dipping the hand under cold water until the curd is well cooled (about ½ minute), then drain the curd in the hand free from water, and examine. If heated long enough, the curd in the hand will drain freely and rapidly and will be as firm as the maker wants the finished product to be.

When the curd thus tested appears "firm enough," empty the jacket, and see that the steam valve does not leak. Draw off 2/3 of the whey (or most of it) rapidly from the vat, and pour in immediately about one half vat full of cold well water, from cans filled previously, to cool the curd rapidly to about 60 de-

grees or lower. Stir with the rake to cool all parts of the curd. Then draw off water and wash again two or three times with cold water. Finally drain the curd on the vat bottom, stir in salt, and pack the cheese. The cheese is thus finished and packed in not over 1 hour after it is thick. No curd rack or bags are used, and the cheese is fresher, and cleaner flavored than if allowed to sour over night. Curd ripened to high acidity over night, or ripened at lower temperature than 100, tends to break up badly into very fine grains, during the stirring. This method has been in use since 1920. No acid test need be used.

Good, pasteurized starter is always desirable, although raw starter is often used. To get a raw starter for the next day, take out several cans from the vat, immediately after stirring in starter and before heating to 100 degrees for ripening. The starter in the cans ripens over night at 70-80, F. Pasteurized milk may be used in the vat instead of raw, by the same method throughout, except that more starter may be needed to ripen it.



Draining in the vat. A curd heated to 110-130 degrees after cutting, cooled thoroughly with cold water, and drained in the vat, can be salted in one hour after cutting the curd.

(166) The important features of this process are (1) to ripen the milk with plenty of starter at 100 degrees so as to get it thick the same day, (2) to cut the curd and make cheese as soon as the

milk is thick, (3) to cool the curd promptly with a large volume of cold water in cans, immediately after drawing the whey, (4) to drain and salt it in the vat. Wis. Bul. 315, (1920).

(167) Salting and Packing. The use of cold water in this way makes the final draining of the curd more rapid than if no water was used. The quick cooling also avoids danger of getting the curd tough and rubbery, which is likely to occur when the curd is drained and left at a high temperature. Probably the early cooling and washing out of the whey also improve the keeping quality of the cheese.

When satisfactorily cooled and drained and not before, the curd is salted, adding 1¼ to 1½ lbs. of salt to 100 lbs. of curd, and stirring it in evenly. All of this salt should remain in the cheese, which is now ready to pack. From 100 lbs. of skim milk, about 16 lbs. or less of cheese are obtained, depending on its moisture content.

From 2½ to 5% of finely ground, canned pimento may be stirred into the cheese after salting, but this is done only on special orders.

The cheese can be packed in tubs, or in tin cans for shipment, and in moisture proof single service containers for the retail trade.

The product should be kept cold, until it reaches the consumer. During long shipment in warm weather, it may spoil in flavor. Some buyers keep it for several months, frozen solid in cold storage, and mix in a little fresh cheese, to improve the flavor after thawing for sale.

(168) Pasteurization of Skim Milk for Cottage Cheese. Skim milk for cheesemaking should be pasteurized because it is more sanitary, better flavored, and keeps longer. Where whole milk is pasteurized before separating, both the butter and the cheese are benefited. The method of manufacture with pasteurized milk is the same as with raw milk, although more starter may be required for souring.

(169) Older Methods. These consume more time, and often consist of leaving the milk at about 72 degrees, with about 2% of starter to sour and thicken over night. The milk may then often thicken long before morning, and reach a much higher acidity than desirable by the time the maker is ready to finish it, often spoiling both flavor and texture.

By the older methods, curds were often heated no higher than 105 degrees, and required several hours to become firm, and were often transferred to a draining rack to finish draining and cooling, in order to get the vat empty in time for the new

skim milk. The long period of holding the milk and curd warm tends to injure the flavor and keeping quality.

Curds made thus are apt to be fine grained, and sandy, and drain more slowly than if coarse grained. Conditions which tend to make curd break up badly into fine grains are unnecessarily high acidity, low temperature (as at 72 instead of 100) when first stirred, and longer period of stirring (from 75 up to 125, instead of from 100 to 125 degrees).

(170) Sweet Curd Cottage Cheese. The modern tendency is to sell cottage cheese having as mild a flavor as possible, and not noticeably sour in taste. This is accomplished in (164) by making the cheese without delay as soon as the milk thickens, and by the several thorough washings with cold water after draining off the whey. Illinois Circ. 445 (1936).

(170A) Cubed Cottage Cheese. Ordinary cottage cheese curd stirred with a rake in the vat breaks up into small irregular shaped pieces. To retain the curd in the form of cubes the same general process as in (164) may be used, excepting that the curd is cut with ½ or ¾ inch curd knives, and is then stirred very gently with a board paddle while heating slowly. By this means the curd is kept in the form of cubes by careful work. A longer time is required for heating and the temperature often need go no higher than 110-115 degrees. With the vat jacket filled with water, heating can be made as slow as desired, or the heating can be done by adding hot water at intervals to the vat. Cubed cheese is more commonly made by the use of rennet.

(170B) Cottage Cheese Made with Rennet. The process is much slower than described in (164). The skim milk from the separator, or pasteurized, is cooled to 72 degrees, and there is added about .1 to .5% of starter and 1 c.c. rennet extract to 1,000 lbs. milk. It is then left over night to thicken and sour. At 90 degrees and with 5 to 10% of starter the necessary .4 to .5% acid is formed sooner. The development of acidity up to about .5% in the whey is necessary, the same as if no rennet was used. It is not advisable to curdle the milk at lower acidity, using more rennet. The curd is cut into ⅜ or ½ inch cubes with ordinary curd knives. While cutting, fill the jacket with water at 115-120 degrees. After cutting, cover the curd with two inches of water at about 115 degrees. Half an hour later, insert a hose and run a slow stream of water at 120 degrees through the curd. This stirs the curd gently, without breaking cubes. Keep the jacket 25-35 degrees warmer than the curd. Stir gently with a broad wooden paddle.

During the next two or three hours, raise the curd temperature slowly (not over 130 degrees) until it is found that the

curd is "firm enough." For a test, a handful of curd is dipped into cold water, to cool it quickly. When this test shows the curd to be as firm as desired, the whole vat of curd is ready to cool and drain.

First, empty the jacket and fill with cold water. Draw off the whey above the curd, and fill the vat immediately with cold water from cans, or in a gentle stream from a hose at the bottom of the curd. Continue filling, stirring, and drawing down, until the curd is about the temperature of well water. Three or four washings may be enough. Empty the jacket of all warm water, and keep it cold. See that the steam valve does not leak.

When well cooled, spread the curd evenly, make a ditch, and drain for an hour. The curd must next be chilled for 12 hours at 30-40 degrees. The curd is put on trays, or into cans, or into butter tubs with a few drainage holes in the bottom and sides, and placed in the refrigerator at 30-40 degrees over night. Or curd may be cooled in the vat by filling the curd into sacks, and piling the sacks with cracked ice between and above the sacks.

Twelve to 15 lbs. of curd is obtained from 100 lbs. skim milk. It may be salted (1½%) and sold without cream, and is sometimes called "pot cheese." 20 to 40 lbs. of skim milk may be mixed with 100 lbs. curd, for five minutes in a mechanical mixer, and is thus in better condition to be creamed by the purchaser or consumer.

(170C) Creamed Cottage Cheese. Cubed cottage cheese made as in (170A, 170B) but not salted, after cooling and draining in the refrigerator, is weighed, and to 100 lbs. of curd in a tub, 10 lbs. of 40% cream, or 60 lbs. of 12% cream is added. By adding 3 lbs. of salt to a 10 gallon can of 12% cream, the cheese contains about 1¼ to 1½% of salt, which is just right for flavor. After five minutes in a mechanical mixer, or a little longer stirring by hand, the curd partially absorbs the cream, so as not to settle out, after packaging.

For the most attractive appearance, the cheese should be kept in good sized flakes or cubes, by slow and careful stirring after cutting.

Some factorymen add cream to cottage cheese only on order, so that if any of the cheese must be thrown away there is no loss of cream.

(170D) Pasteurization of Cottage Cheese During Manufacture. It is possible to modify the method, keeping the curd in large flakes by stirring very little, and heating slowly up to 145 degrees for 20 minutes, and finally drawing the whey and cooling the curd with cold water before salting, and in this way to

give the cheese a practical pasteurization during the making. This may consume more time, but there is no chance of contaminating the product through use of a poor starter. If the curd is stirred too much, it will break up into small pieces, and become tough or sandy. Few makers use this method.

(170E) Making Very Soft Cottage Cheese—Baker's Cheese. Cottage cheese sold to bakers should be much softer than when made for table use. For this purpose the milk is left to sour at such a temperature that it will cool down to about 75 degrees. After cutting, and stirring at this temperature, the curd may be dipped from the vat to a flat, cloth covered, draining rack, and left to drain half a day or over night. While yet quite soft, like quaking mortar, it is packed in cans without salt, and shipped to the buyer. The yield is about 20-22 lbs. cheese per 100 lbs. skim milk. See also (184).

(170F) Cottage Cheese from Dry Skim Milk. Skim milk may be enriched by adding 3 to 5% of the best quality spray process or vacuum-drum process powder or the powder may be dissolved in seven times its weight of water at 90 degrees, F.

Coagulation is obtained by adding 5% of starter, and 2 c.c. rennet and 2 c.c. 25% calcium chloride solution, and holding five hours at 86, F. The curd is heated finally to 120-130, drained, washed, chilled, salted and creamed. Special directions as to details are given in bulletin 701, by W. H. E. Reid, Dairy Department, University of Missouri.

(170G) Gelatine and Cottage Cheese. Where curd is made in the spring, frozen, and held until the summer or fall, gelatine has been used to enable the thawed curd to hold its shape, so that each curd grain retains its identity as in fresh curd. For this purpose, one half of one percent of gelatine is used to the weight of the skim milk. (a) If the skim milk is to be pasteurized in a coil pasteurizer, sprinkle the dry gelatine over the top of the skim milk in the pasteurizer with the agitator revolving, and before heat is turned on. This allows the gelatine a few minutes to soak in the cold milk before it is heated to the pasteurizing temperature.

(b) If skim milk is not to be pasteurized, soak gelatine 10 minutes in 10 parts cold water to 1 part gelatine by weight. Then heat to 120 degrees in a water bath, to dissolve it. Next heat 1 gallon of milk to 100 degrees, add the dissolved gelatine and stir thoroughly. Add this to the bulk of skim milk and stir thoroughly.

For creaming cottage cheese, add 5 ounces gelatine to 10 gallons cream by method (b) above.

Gelatine, etc., may also be used in making cream cheese (185A), skim milk buttermilk, etc.

(171) Experiments in Curdling Milk. While fresh milk can be heated to boiling without curdling, milk ripened to .3% acidity or more will curdle at temperatures below boiling, and at .5% acidity or more will curdle at room temperatures.

Not only the proportion of acid in milk, but also the proportion of almost any other substance added to milk affects more or less the temperature at which it will curdle.

The temperature at which milk curdles can be observed without difficulty by placing a thermometer and 1 or 2 c.c. of the milk (enough to cover a thermometer bulb) in a test tube, and holding the tube in a 200 c.c. beaker half full of water, which is slowly heated over a bunsen burner. By moving the test tube most of the time, the water is well stirred, and the instant that visible coagulation occurs in the milk, the temperature can be read on the thermometer. Duplicate tests on the same milk usually agree within two degrees, Fahrenheit.

(a) With a pail full of sweet skim milk, at about 40 or 50 degrees, Fahrenheit, 1 pint portions can be quickly brought to different higher acidities by shaking the milk while running in from a burette, 1, 2, or 3 c.c. of N/1 strength hydrochloric acid. If the milk is cold and well shaken, curdling should not occur during the addition of the acid.

(b) Each lot of acidulated milk may then be tested with the acidimeter for its acidity, and finally tested as described above to determine the temperature at which it will curdle.

(c) Different pint portions of skim milk can be brought to different degrees of ripeness by holding them for a few hours at warm temperatures, from 80 to 105 degrees, and the milk at different acidities may be tested for its coagulation temperature.

(d) If instead of hydrochloric acid in (a) there be used a N/1 solution of lactic, or acetic, or phosphoric acid, quite a different set of coagulation temperatures will be observed, at the same molecular acidities. Can you explain why?

(e) Other substances beside acids strongly affect the coagulation temperature. Starting with a lot of milk which because of ripening, or the addition of an acid, will curdle at about 150 to 170 degrees, and adding small proportions of calcium chloride, of common salt, or almost any other soluble salt, it is found that the curdling temperature is raised or lowered. See Wis. Expt. Sta., Rept. for 1907, page 176ff.

(172) Cottage Cheese from Buttermilk—Buttermilk Cheese. Buttermilk from old, gathered cream is likely to yield curd having a disagreeable, old flavor in comparison with cheese made

from freshly soured skim milk. On this account, probably, cheese from skim milk is preferred in some markets, since it is more likely to be uniformly good in flavor.

(172A) A Remarkable Difference. If a skim milk curd is heated too long, or to too high a temperature in the whey, the cheese is sure to become tough, rubbery, or sandy and unattractive for table use. But curd from buttermilk is different, in that it may be heated to 140, or 160, or even higher for an hour or more, without the slightest danger of obtaining a tough or sandy curd. (Wis. bul. 211—May, 1911.) It can be instantly rubbed out to a smooth paste with a little water in the hand. Starting with buttermilk it is impossible by any known means to make a curd which is tough or sandy, or which will not quickly absorb water applied to it. Attempts to make a Cheddar cheese from sweet buttermilk failed.

The difference between skim milk and buttermilk appears to originate in the centrifugal cream separator where apparently the cream proteins and the skim milk proteins and other constituents are more or less separated from each other. Investigation may explain this difference more fully.

(172B) Making Buttermilk Cheese. The method of making cheese from raw cream buttermilk is as described in (160), but after the curd has drained on the rack for about half a day it is dry enough for table use and should be salted with 1¼-1½% of salt well stirred in, and packed for sale. Water stirred in to moisten the salted curd, if too dry, is quickly absorbed.

In several large towns and cities, buttermilk cheese has found ready sale, but in the largest cities, the demand for buttermilk for drinking purposes makes it impossible to supply buttermilk cheese except by shipment from outside creameries.

Sweet cream buttermilk must be ripened with starter at 100 degrees until it will curdle at 130 degrees, like raw cream buttermilk. Wis. Bul. 239 (1914).

(172C) Sour, Pasteurized Cream Buttermilk. When sour cream is pasteurized the temperature and the high acidity cause the casein in the cream to curdle in the pasteurizer in very fine grains. These grains pass through the churn with the buttermilk, but when such buttermilk is heated to make cheese the curd separates as a slimy mass like chalk and water, but can not be drained rapidly, or made into a satisfactory product for table use. The curd from such buttermilk can be recovered in good condition by means of a centrifuge. Or, to the cold buttermilk there may be added (1) a lye solution evenly stirred in until the mixture is alkaline to phenolphthalein, and (2) hydrochloric acid, evenly stirred in to neutralize the lye, in such quan-

tity as required until a test portion of the well stirred mixture, on heating to 140 degrees, wheys off clear and gives a curd like a raw cream buttermilk curd in texture. The lye dissolves the fine grains of curd formed in the pasteurizer and the acid precipitates the curd again at a moderately low temperature, as occurs in handling raw buttermilk. The flavor may be sharp and acid.

(172D) Uncolored Buttermilk Cheese. Buttermilk carries a part of the butter color from the churn, and the cheese also has a noticeable color, different from cottage cheese. To make a white buttermilk cheese, mix the butter color thoroughly with the salt weighed in a tub, before adding the salt to the butter. The butter will be evenly colored, if properly worked.

CHAPTER XXIII.

Cured Cheese Made from Sour Milk Curd

After dry cottage cheese curd has been cured or fermented for a few days or weeks, it can be ground fine, and molded into forms for final curing.

(174) Hand Cheese Manufacture. This cheese so-called because originally molded into balls or cakes by hand, is made in Europe in a great variety of herbs, as caraway, thyme, marjoram, hops, pimento, mace, cayenne and often with beer, wine, etc.

One or two factories in this country make a sufficient supply of hand cheese, to meet the demand.

(175A) Sap Sago Cheese from Sour Skim Milk Curd. This cheese, called in Europe schabziger or green krauterkase, has been made for 4 centuries in Canton Glarus in Switzerland and is imported to America in cone shaped pieces about 4 inches high, 3 inches in diameter at the bottom and 2 inches at the top. The color is gray-green, the texture is compact and hard and the odor aromatic. Small quantities have been made in Wisconsin with good success.

The skim milk should not be sour enough to curdle on boiling, as such curd will be too dry and hard for this cheese. The skim milk is heated to boiling in a copper bottomed kettle or pail to avoid burning. Cold buttermilk is added to raise the acidity to about .20%, but in small quantities at a time to avoid curdling and the kettle is heated again. A portion of sour whey is spread on the surface of the milk, the kettle is drawn from the fire and left quiet. Soon the surface layer thickens and this curd is taken off with the scoop. The remaining liquid is stirred and enough sour whey added to thicken it all and separate clear whey. Too much sour whey used here makes the curd hard and crumbly and gives the cheese a sour taste. Too little sour whey leaves the whey milky and the curd is soft and sticky and retains too much whey which cannot easily be pressed out.

The whey is drawn and the curd is laid in wooden troughs in a thin layer to drain and cool. The cool curd is placed in wooden forms having draining holes in bottom and sides, covered with a board and pressed moderately by adding weights. It is left thus for 3 to 6 weeks protected from flies to ferment, best at 60-65 degrees F. This "fermented white curd" is sold in 150-lb. sacks to cheesemakers.

The maker grinds the curd several times through the special roller, curd mill to a smooth paste, with 4-5 lbs. salt and 2.5 lbs.

dried clover leaves for each 100 lbs. curd, until the mass is uniform. A wooden mold is lined with cloth and the curd is packed in tightly and the maker's stamp imprinted on the bottom. The cheese is then tipped out of the mold and dried in a room protected from extremes of temperature which cause cracking and from direct sunlight which bleaches the color, but with good ventilation for 2 to 6 months before it is packed for shipment. The cheese is grated fine and spread on buttered rye bread.

Six or seven pounds of ripened cheese are obtained, besides butter, from 100 lbs. of milk. The clover **Melilotus (Trigonella) coerulea,** is grown for the purpose and, before it blossoms or goes to seed, dried in a cool, shady place for 2 or 3 weeks, or may be dried a short time in a steam oven. When well dried, it is rubbed fine, sifted free from stems and is ready for use as a very fine green powder.

(175B) Cooked Cheese-Kochkaese. Make a fairly dry cottage cheese. Grind the curd through a meat chopper, and spread it about four inches deep at 82-86 degrees, and cover with netting to exclude flies. After 46-60 hours at this temperature, or a longer time at a lower temperature, the curd has softened and settled. It is heated in a starter can with scraper inside, or in a greased skillet, or in a double boiler, to about 180 degrees. To 100 lbs. curd, stir in 2 to 4 lbs. butter, or less butter and some milk, also 1½ lbs. of salt and half a pint of caraway seed. When the hot curd drops from the ladle like honey, run it into packages for sale. Cool it and keep it cold.

(175C) Gammelost. This Norwegian cheese is made from pressed sour skim milk curd, dipped for ¾ to 1 hour in boiling hot whey, then pressed in a form. After a few weeks it is packed in jars in moist straw. After 2 or 3 months it is ready to eat. It is imported in tin cans, and has a golden brown color, and a strong flavor. The name means "old" cheese.

(175D) Pultost. Another Norwegian cheese called pultost or knaost, is made from pressed and finely ground cottage cheese, which is then left at a warm temperature to ferment. After mixing with caraway and salt, the mass is rubbed fine again, and packed in wooden containers, and either eaten fresh, or after one or two months.

CHAPTER XXIV

Fresh Soft Rennet Cheese

(178) Junket. The preparation of junket is interesting and instructive, as an example of the simplest possible use of rennet.

Fresh milk is sweetened, and flavored with vanilla, peach, or any other preferred flavoring, as for ice cream, or in about the following proportions:

3 quarts of sweet milk
1 pound of sugar
½ ounce of vanilla extract.

This mixture is heated to about 90-95 degrees, and junket tablet solution is added, or rennet extract at the rate of 2 c.c. extract for the quantity given above. Immediately after stirring in the coagulant, pour milk quickly into cups, and allow to stand warm and undisturbed until well thickened. Carry the tray of cups to the refrigerator, and leave for half an hour or more, until the material is well chilled, when the junket is ready to be eaten.

Junket tablets may be purchased at almost any grocery or drug store in two sizes for different quantities of milk. The tablet is dissolved in a little cold water and used instead of rennet extract. The tablets keep well for a long time in the dry form for occasional use in the household.

(179) Neufchatel Process. Neufchatel cheese is commonly sold in small 10-cent packages, wrapped in tin foil, or in small glass jars under a variety of names. It is made from either whole milk or skim milk and sometimes from cream or milk to which some cream has been added. It is often called cream cheese, when made from whole milk or cream.

It was formerly made in France from milk or cream thickened by souring, and then wrapped in a cloth, which was hung up to drain. The cloth had to be changed frequently or the contents stirred and scraped down before the draining was complete. This process has been improved in America, so as greatly to lessen the labor required and systematize the manufacture. (Farmers Bul. 960). Circ. 94, Ames, Iowa.

An early form of the process in this country consisted in thickening sweet milk with rennet extract in milk cans and pouring the curd thus obtained into a yard square of cloth, stretched over an oblong wooden frame and fastened to the four corner posts by slipping an iron ring over the cloth at the top of each post. This process requires labor to handle and wash a great many cans and wooden frames.

Another draining arrangement consists of 2 parallel strips of 2 by 4 inch lumber, about 30 inches apart, with wooden pegs inserted about 18 inches apart. A long strip of muslin with short tie strings along both edges, is spread along the frame, and tied to the pegs, making a series of bags. The milk is thickened in cans and a can of curd poured into each bag.

To avoid the use of cans, and to permit early cooling of the curd, the modern process for making Neufchatel cheese begins by thickening the milk in a vat and drawing the curd through the gate into muslin bags. After draining the whey out, with occasional shaking of the bags, they are put in a press for a short time. When sufficiently dry the curd is emptied into a trough, where it is mixed with salt and other flavoring material, if used, and is then run through a machine, moulding it into cakes, which are wrapped by machine or hand in paper and tin foil and packed in flat wooden boxes for sale. The cheese is easy to make but like other high moisture products, requires much advertising to secure sale before it has time to spoil. The retailer should receive fresh stock at least twice a month or oftener, and any spoiled, unsold stock is usually replaced by the manufacturer.

(180) Cream Cheese or Whole Milk Neufchatel. Made from whole milk or with milk enriched to contain 5 or 10 per cent fat, the product is usually labeled "cream cheese" and put up in 3 or 6-ounce packages, of square or oblong form (Neb. bul. 303).

The whole milk, with or without added cream, is run into a vat and heated to about 72 degrees. Sometimes a very little starter is also added, if found necessary, and about 1 to 2 ounces of rennet extract per 1,000 lbs. of milk is then thoroughly mixed in. The vat is left undisturbed until the next morning. With whole milk, this quantity of rennet is necessary to secure thickening before too much cream has risen. During the night, the milk ripens slightly and thickens. The next morning the curd is cut in the usual way with American curd knives, into cubes, but no heat is applied. Immediately after cutting, a test of the whey should show at least .30%, or up to .5% acidity. If the milk had not ripened, the whey would test only .12 or .15% and the curd from such sweet milk tends strongly to retain whey, so that it cannot be readily drained, or pressed dry enough for salting.

If the factory milk supply does not ripen fast enough at 72 degrees, without starter, the milk may be set at 75 or 77 degrees or about 1/10 of 1% of starter may be added before the rennet is stirred in. In cold weather the milk may be set warmer so as to thicken and cool down about 70-72 over night. (Farmers Bulletin 960.) (U. S. Dept. Agric. bul. 669.)

(181) Draining the Curd in Bags. After cutting the curd, a muslin bag, about thirty inches long and eighteen or twenty inches wide, made of pillow case tubing, is put under the gate and filled nearly full of curd The neck of the bag is then tied shut and the bag is hung up by the tie string on a hook to drain for 24 hours. It may be necessary to shake each bag vigorously once in two or three hours to mix the contents, as the curd next the cloth drains dry quickest and may form a layer next to the cloth which delays the draining of the curd in the center. The temperature and acidity at which this curd drains most easily should be determined by experiment.

(182) Cooling the Curd. The curd is cooled when partly drained in order to check fermentation and to reduce the loss of fat in subsequent pressing and is kept cold until packed and shipped, in order to preserve the good flavor as long as possible.

Draining hooks on which the bags of curd are hung may be attached permanently overhead in the make room, and in this case the bags of partly drained curd can be taken down and loosely packed with cracked ice in a draining trough and left over night.

If the draining hooks are attached to a movable frame which can be wheeled about on castors, the frame carrying the bags on the hooks is pushed into the refrigerator where it is left to drain over night, and cool thoroughly.

It is possible to omit this cooling process entirely, if the curd is to be eaten soon without shipment to a distance. The drier this cheese is made, down to 40% and the colder it is kept, the longer it will keep.

(183) Pressing the Curd, Salting and Packing. The next morning the bags of curd are shaken so as to collect the contents at the bottom, and the bag above the curd is twisted up to prevent loss of curd while pressing. The bags are placed in a vertical press (157) in layers, alternating with wooden slat frames, about 30 inches square, which keep the pile from falling over. The screw press is tightened so as to keep the whey running for about 20 minutes or until the curd is dry enough. The bags are then turned inside out, emptying the curd into a tin trough, 1 foot deep and 2 by 2 feet or larger and set like a table on legs with castors, so as to be wheeled about. To make the curd perfectly smooth, it is commonly run through a power food chopper. The curd is mixed in the trough and salt at the rate of 1¼ to 1½ lbs. per 100 lbs. of curd is stirred in evenly. Two and one-half to 5% of finely ground canned pimento may also be added or other flavoring matter, as chopped olives, nuts or a mixture of these.

The curd is then put into the hopper of a soft cheese packing machine, which, by the action of a conical screw, forces the curd through a nozzle of the desired shape, and delivers the cheese in cakes ready for wrapping. The tin foil has attached to it a lining of thin parchment paper. The cakes of cheese are wrapped by hand or machine, and packed in wooden flats holding one or two dozen.

The cheese is also packed and sold in 3-ounce or larger jars of glass, either white or transparent and sometimes is put up in 1- or 5-pound cartons for hotel use, or for cutting on the retail counter.

(183A) **Flaky Cream Cheese.** Recently developed methods intended to produce a flaky, shorter textured cream cheese, rather than the more pasty, buttery texture of ordinary Neufchatel whole milk cheese are about as follows. Milk enriched to 5, 6, or sometimes 15% fat, is pasteurized at 145-150 degrees for ¾ hour, cooled to 130, and homogenized at a high pressure, cooled to 80 degrees, and 5 to 10% of starter is stirred in, so that the milk thickens by souring in about three hours. One c.c. or no rennet is used per thousand pounds. The curd is cut and bagged as soon as it is thick, to avoid higher acidity than necessary for thickening. When partly drained, the bags of curd should be moved into the refrigerator, or packed in cracked ice, in a well drained trough and kept cold thereafter until sold, as such cheese tastes better and keeps longer. When well drained, the bags of curd are pressed in a vertical press, at moderate pressure to remove loose moisture, after which it is run through a grinder, salted and packed while cold. The reduction of the moisture content by this process to about 40% may give a better keeping cheese than the older rennet product containing 50% moisture.

(183B) **Mould Growth in the Package.** Moulds require for their growth both air, moisture, and a suitable warm temperature. Neufchatel cheese often shows yellowish spots on the cheese surface under the wrapper, after being kept out of the refrigerator for several days. The yellowish spots show where enough air had penetrated under the wrapper to promote mould growth, while adjacent white parts show where the wrapper adhered so tightly that lack of air prevented the growth. The growth is nearly white, as the black, red, or bright colored "fruit" of mould does not develop under these unfavorable conditions, due to lack of air.

(183C) **Goat Milk Neufchatel Cheese.** Goat milk can be used alone or mixed with cow milk for making cheese of various kinds. (62). As the supply of goat milk is small, it is fre-

quently made into a high moisture cheese to get as large a yield as possible. Goat milk Neufchatel cheese is made by practically the same methods as described above. The milk may be pasteurized at 143 degrees F. for 25 minutes if desired. The morning and night milk may be mixed in the evening and set to thicken over night. Goat milk contains about 3 to 5% of fat, and about 11 to 15% total solids. Cal .bul. 285, (1917). Also Goat Roquefort cheese; Cal. Bul. 397 (1925).

(184) **Neufchatel Cheese from Skim Milk.** The process with skim milk is the same as described above for whole milk, excepting that about one-tenth as much rennet is used. As the curd contains no fat which might be lost by rough handling, the curd is not hung on hooks but the bags are piled on a wooden slat draining rack placed on the floor. The bags are repiled about once an hour and at times may drain so rapidly that they can be pressed the same day.

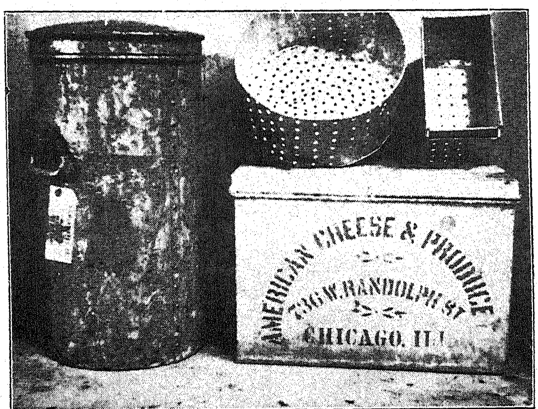
The pressing, salting and packing is done as described above, excepting that the shape of the 3-ounce cheese is not oblong, but cylindrical, when made from skim milk. When made quite soft and packed in tubs, it is often called bakers' cheese (170E), and used as a base for making cheese spreads (235C).

(185) **Neufchatel Cheese in Loaves.** Skim milk Neufchatel is also put up in 5- or 10-pound loaves, wrapped in parchment paper, ready to be cut with a string on the retail counter into pound slices or larger, as called for by the consumer. By this method the expense of hand wrapping and tin foil wrappers is avoided and the product can be sold at a lower price with profit

For this purpose, the skim milk in large vats is heated to about 72 degrees and set with 1/10 ounce rennet extract per 1,000 lbs. of milk, well stirred in, at about 3 p.m. The temperature may be somewhat higher, up to 80 degrees, if necessary, to get the desired acidity as indicated below. About 4 a.m. next morning the milk should be found well curdled, and the whey acidity at about .30 or .35%, but not lower than this. If 1 to 5% of starter is added to the milk early in the day, it may have enough acid by 4 p.m., and the curd can be cut the same day. The curd is now cut with ordinary curd knives, preferably with blades. After cutting, some makers heat up the surface of the curd next the tin vat, by running steam into the jacket, with no stirring. This may allow the curd to drain more freely next the tin, later, or it may be omitted if thought useless.

About ½ to 1 hour after cutting the curd has settled somewhat under the whey and a vat strainer is put in above the gate and the whey allowed to drain out slowly. When down to the level of the curd, the curd is dipped out with large scoops in thin

layers into a cloth covered draining vat, made of smooth boards with a wooden slat bottom. After dipping the curd the vat is washed ready for fresh skim milk. The curd drains in the rack, and a ditch is made around the edge with an opening through the bottom in each corner to carry off whey from the top. After draining an hour or two, until the loose whey is all off, salt is sprinkled all over the top of the curd, but not stirred in. A little later, the curd is cut vertically in thin slices with a tin scoop and filled into tin molds holding 7 or 8 lbs. of cheese, 4½ inches square at the end, and 9 inches long, slightly larger at the top than at the bottom. The form is lined with cheese cloth before filling, and the filled forms are piled three or more deep, for slight pressing, and are placed in the refrigerator for chilling.



Loaf Neufchatel Cheese. Perforated molds for draining the curd, and shipping cans are used for this product.

The molds are perforated with ¼-inch holes 1 inch apart, so that the draining is readily completed on the same day. The loaves of curd hold their shape well, and after several hours are turned out of the molds, and wrapped in parchment paper and packed 12 in a tin shipping case. The cheese may also be made in round moulds 6 inches deep and 12½ inches in diameter, and are packed in a round can.

Like Neufchatel cheese, the product is eaten while fresh.

(185A) Homogenizer Method for Neufchatel Cream Cheese. Instead of removing whey by coagulation and drainage, a method has been devised (Jrnl. Dairy Sci. Vol. 10, p. 106, March, 1927) by which sweet cream, 40-45% fat content, is treated with 3 to 5% soluble skim milk powder, and either 1% of gelatine or .5% powdered agar, pasteurized at 145 degrees

for 30 minutes if gelatine was used, or at 180-185 degrees for 10 minutes if agar was used, cooled to 110 degrees, treated with .75% common salt and .5 to 1% good starter, and then homogenized at 3,500-4,000 lbs. per square inch. The cream as it leaves the homogenizer has the consistency of soft butter, or is slightly stiffer than ice cream as it comes from the freezer and can be packaged conveniently at this stage. It is cooled to 70 degrees in an hour or two in the refrigerator (at 32-40) then held at 70 degrees for 10 or 15 hours to develop a mild acid flavor, and is ready for use, but can be stored at 32-40 degrees for several weeks without any serious deterioration in flavor. No rennet is used. (N. Y. Tech. Bul. 226.) (Mo. Circ. 179.)

(186) Coulommier Cheese, Made in Hoops. Neufchatel cheese is stirred up with salt and then moulded into shape after draining and pressing, while the Neufchatel curd in loaves is molded into form during the draining process.

It is possible also to put the curd into molds at the beginning of the draining process, so that when fully drained the cheese have their final shape, which they retain during the salting process and until eaten.

Cheese of this class are made by dipping the rennet curd with a ladle into small tin hoops, in which the draining takes place. The cheese take their shape from the hoop and are salted on the outside. Coulommier cheese and a few other kinds are eaten fresh without curing and for this reason are easier for the student to make, as an introduction to the subject.

Mixed night and morning milk of good quality and not over .20-.21% acidity may be used. With very sweet milk, ½-1% of starter may be added, in order to avoid gassy cheese. The milk, at about 86 to 90 degrees, is thickened with enough rennet extract, so as to be smooth, firm and ready to cut in about 1 to 1½ hours. It may be top stirred to keep down cream before visible thickening begins.

For a rapid process, add enough starter to raise the acidity to .22-.25%, thicken with rennet in 30 minutes at 86 degrees F., cut, settle 15 minutes and dip into hoops. This early removal of whey from curd greatly hastens the draining process in the hoops.

The curd is transferred with a round bottomed, sharp edged ladle to tin hoops, which stand on straw matting or on coarse cloth, as burlaps, spread on grooved draining boards, usually made of wood. The ladle should be small enough to reach down into the hoop, so that the curd can be gently laid on the bottom, without breaking. Four hoops, 5½ or 6 inches deep, and 3 to 5½ inches in diameter, and open at both top and bottom, stand on one board which is about 12 by 14 inches. The sides of the

hoops may be perforated with holes 1/8 inch in diameter and about 1 inch apart. The hoop is best made in two halves, the upper half fitting into the lower half about half an inch.

After filling the hoops, any remaining curd may be added to the top of the first hoops filled, after the curd has settled somewhat.

In about 20 hours, or sooner, the curd has shrunk into the lower half of the hoop, so that the top half may be taken off. The rate at which the whey is expelled depends on several factors. With quite sweet milk, the curd drains more slowly, so that it is better to have the whey acidity at least .18-.20% when the curd is dipped. The make room should be at about 60 to 75 degrees, best at 68 degrees, and not too dry. At a lower temperature, the curd drains very slowly. If dipped in thin slices, the curd will drain more rapidly than if in thick slices.

When the top half of the hoop is removed, a square of matting or coarse cloth is put on, and another draining board, and the hoops together with the boards are turned over. The curd begins to drain again more rapidly from the side now underneath. The upper board and cloth are removed and the top rind of the cheese, showing the pattern of the cloth or matting is sprinkled with about 1/8 ounce of salt. The next morning the cheese are turned again and the other end and edge are salted. The cheese may be salted by dipping in strong salt brine 30 to 60 minutes, if preferred. After 24 hours further draining, the cheese are ready to be wrapped in parchment paper with or without tin foil, packed in individual boxes, sold and eaten. They may be kept a few days, if cool and well covered to prevent drying out. In handling the cheese care is used at all times not to break the rind or surface. Read bulletin 172, Ontario Agricultural College, Guelph, Ontario, Canada. Also, Exhibition Circular 22, Dept. of Dairying, Ottawa, Canada.

CHAPTER XXV

Soft, Ripened Rennet Cheese

(187) Camembert Cheese. This variety of cheese, originally made in France about 1800, is now made in a few factories in this country with more or less success. The very moist curing room conditions, occurring naturally in northwestern France, are hard to supply in this country, because of the drier climate here. Pasteurized milk may be used. Jour. Dairy Science 1927, 448.

The methods and equipment in French factories are described in bulletin 58 and others from the Storrs Expt. Station, Connecticut, and the Dairy Division, Washington, D. C., and in Farmers' Bulletin 384, and U. S. Dept. Agric. bul. No. 1171. Bureau of Animal Industry bul. 98. Ont. Agric. Col. bul. 206.

The make room should be at 60-70 F., as below 60 F. the separation of whey from curd is delayed, or even entirely interrupted. Night and morning milk in good condition, at 85 degrees F., is set with about 3% starter, and ripened to .20-.23% acidity, but if at .24-.25% acidity a mealy curd is likely to result. A starter tasting quite sour but not yet curdled is preferred. With the milk in a vat or in 200 lb. cans on trucks, with wheels, rennet at the rate of 3.5 ounces per 1,000 lbs. milk is used, and the curd is ready in 1¼-1½ hours. The curd may be cut and stirred a few minutes before dipping which will hasten the draining. Or with the room at 68 F., the curd may be dipped directly into the hoops without cutting. In 18 hours the curd should have shrunk to 2 inches in thickness and can be turned over without breaking. Hoops with small holes and smooth inside surface facilitate settling and turning. The hoops stand on mats on a draining board and table (186).

When first turned, the cheese may be inoculated with a mold culture, if this is to be done, and are then salted on one side. Twelve hours later they may be turned again and salted on the other side. Use dry salt and avoid too much. They are then placed on salting boards, 24 by 30 inches, holding 30 cheese, and set on an upper shelf in the make room, leaving the draining table empty. By the third afternoon the cheese may be taken to the curing room. Here they are placed upon open frames containing cane or wooden strips about 1-1¼ inches apart, so as to expose the cheese to the air both at top and bottom, and permit growth of mold.

During salting, the cheese contain about 60% of moisture, and when fully cured, about 50%. In the curing room, at 52-58

degrees F., and with high humidity, the cheese gradually dry during 2 or 3 weeks and then lose very little afterward. For the details of curing, see bulletins referred to.

At 60 F., in three weeks' time, cheese may be almost fully softened inside, but at 50-54 degrees may be only half ripe in that time. Ripened quickly, they must be used at once or will decay and smell ammoniacal. Ripened in four weeks or more they keep longer but are generally wrapped in parchment, or tin foil and boxed when three weeks old or less. The soft, ripened curd is alkaline to litmus, but the fresh curd is acid. (Hansen's Cheese Press, Vol. 2, No. 4, 1924).

(187A) Curing Room Conditions. In making soft cured cheese of any kind, the curing room is apt to be too dry, unless well filled with moist cheese, and kept closed from outside ventilation. A small quantity of cheese is best cured in a small tight cupboard or under a box, kept wet inside.

(188) Brie Cheese. Fromage de Brie, or Brie cheese is made in about the same manner as Camembert cheese, but in hoops 10 to 12 inches in diameter. The finished cheese is of a soft, almost creamy texture. A very fine example of this general class of cheese with a mild Limburger odor is the Fromage de la Trappe, made at Oka, Province of Quebec, Canada, and sold by many dealers in the United States (New York bul. 662, 1936).

(189) Soft, Ripened Rennet Cheese Heated After Cutting. While the preceding rennet cheese are dipped into the hoops, without previous cutting, at the temperature of the vat, the Limburger cheese process introduces a further modification, in that the curd is cut into cubes with knives and the cut curd is held in the vat for some time, stirring and slowly raising the temperature, so as to expel a large part of the whey before the curd is dipped into the forms.

(190) Bel Paese Cheese. Containing 44 to 46% moisture, this cheese resembles Limburger in slicing and spreading quality, but due to washing, drying and paraffining the rind, before wrapping, the rind odor of Limburger (wrapped wet) is minimized or absent, and the flavor is mild (too mild for processing into a blend). U. S. Dept. Agr. Circ. 522 (1939).

Good quality raw or pasteurized milk is treated with ¼% of lactic starter, and set at 104-110 degrees F., with enough rennet to curdle, fit to cut, in 15 to 20 minutes. The rennet is mixed with 20 volumes of cold water, and mixed in by stirring for one minute; then motion is arrested. The work room is kept at 85-100, F.

Three-eighth inch knives are preferred for cutting as the curd may be too hard to cut with 1/4 inch knives. The curd is stirred gently, and usually without heating, until firm enough, although it may be heated if necessary.

When the curd is "firm enough" the whey is drawn down to the curd level, and the remaining whey with the curd is dipped into forms, on the burlap or reed-matting covered draining table. Draining in a room at 80-90 degrees, is usually finished in 5 to 7 hours. Followers help to keep curd warm. The cheese are turned 4 to 6 times, to keep the top edges square.

After draining, the cheese are placed in brine (17-19% salt) at 54-60 degrees for 14 to 18 hours, sprinkling the upper surfaces with a little salt. This also helps to maintain the brine at the proper strength, S. G. 1.127 to 1.143, or salinometer 64 to 72, at 60 degrees F. (216)

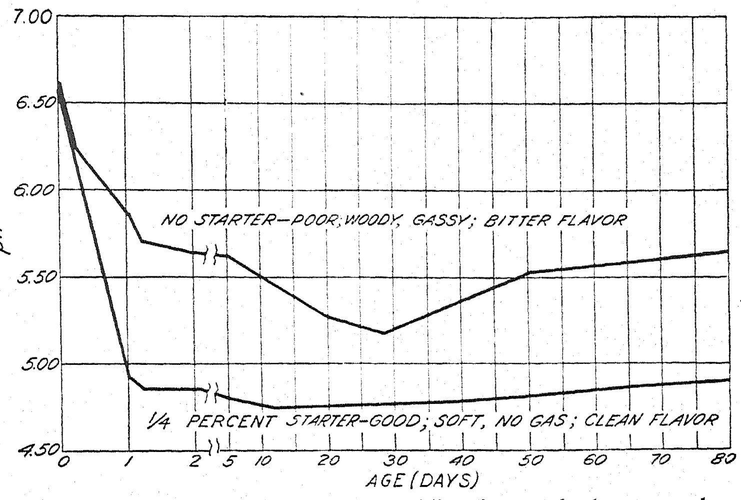
After salting, the cheese are put in a curing room at 38-42 F., humidity about 85%. After curing 3 or 4 days, the cheese may be colored with cheese color, with a brush, coloring one side one day, and the other side after turning on the next day. The shelves should be kept clean. A thin slime grows on the surface, but there should be no yeast or mold growth. Occasional washing with weak brine, and frequent rubbing (smearing) and turning the cheese on to clean boards is necessary.

After 20 days curing, the cheese are washed clean and allowed to dry, but not crack. They are then dipped 6 seconds in paraffine at 210-220 F. and wrapped in either cellophane, parchment, waxed paper, aluminum foil or tin foil, wrapped in heavy paper, put in cartons, or boxed. Two to six weeks further curing is required at the temperature of the curing room. The whole process resembles Limburger.

The cheese forms may be of metal and round, 7 1/2 inches diameter, 6 inches high, like Muenster moulds, with six rows of twenty 1/8 inch holes, or they may be of metal or wood, 8 inches square, 6 inches high, having 1/8 inch holes, drilled in rows 1 inch apart and staggered, with 1 3/8 inches between holes. Other sizes and shapes may be used.

The acidimeter test may be applied to whey immediately after cutting, and again to whey just before dipping, which should show normally a small increase. This increase can be compared from day to day, to detect abnormal ripening. H. A. Bendixen, in U. S. D. A. Circ. 522 (1939). Nat. B. and C. Jrnl. Sept. 10, 1938.

As with other cheese, acid development should be regulated within limits, to secure proper firming of curd, and curing of cheese. Acidity control by the pH test applied to curd throughout curing, is shown in the figure below. (40, 213A).



Bel Paese.—Proper development of acidity in good cheese made with starter added (lower curve), and improper acid development in poor cheese made without starter (upper curve). From U.S.D.A. Circ. 522, p. 6 (1939).

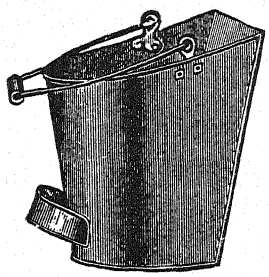
(191) Limburger Cheese. This important variety, which originated in Belgium, is made at about 60 factories in southern Wisconsin and in a few other states. The partly cured cheese is wrapped in parchment paper and tin foil before packing it for market. The tin foil excludes air, and thus promotes the growth of anaerobic bacteria in the cheese, producing the characteristic flavor. The tin foil wrapper also retains the flavor in the cheese, until unwrapped by the consumer. If a well cured Limburger cheese is unwrapped out of doors and a thin layer of rind, about ⅛ inch thick, is cut from the entire surface with a sharp knife, the clean soft interior of the cheese taken to the table exhibits far less disagreeable odor and the cheese thus prepared is spread on rye bread and is relished by many.

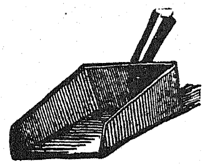
(192) The Milk Supply. For making Limburger, only the best and cleanest milk should be used, as gassy or tainted or overripe milk is sure to produce an inferior product. For sweet milk cheese such as Limburger and Swiss cheese a much better quality of milk is essential than for American cheese since the development of acid in milk for American cheese does much toward checking the production of gas and tainted flavors in the cheese. Several makers pasteurize the milk.

In warm weather milk for Limburger cheese has been brought twice a day to the factory, while fresh and warm from the cow, and is made into cheese as soon as received, both night and morning. If quickly cooled at night and properly cared for

on the farm, night and morning milk may be mixed together with good results, at the factory.

(192A) The Process of Making. The milk in the vat at about 86-90 degrees, is set usually without starter and with enough rennet (3½ to 5 ounces per thousand lbs.) so as to cut in about 25 to 30 minutes. Sometimes to prevent gas ¼% of lactic starter is used without delay. After cutting with ½ inch curd knives into cubes, or with a vertical knife and scoop (210A), the curd is stirred and after 10 to 15 minutes it is slowly heated to about 95 degrees. About three-quarters of an hour after cutting, the whey should not test over .15% acid. The curd is ready to dip, while quite soft, so that a handful of it





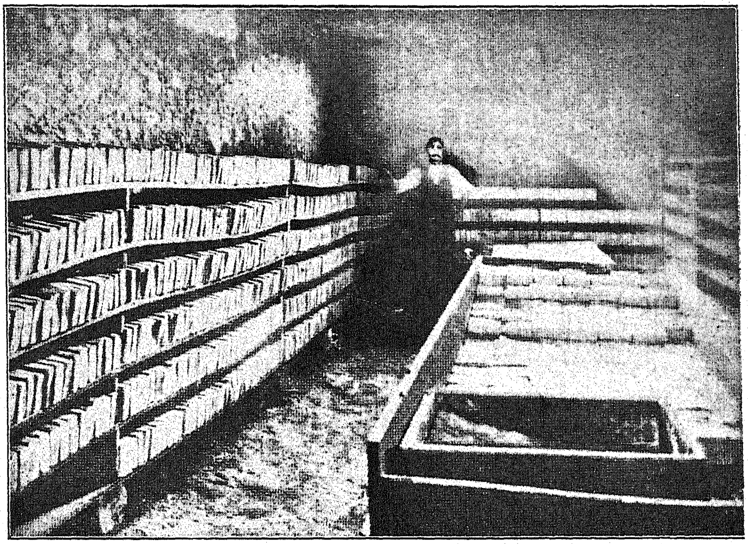
sticks together in a mass, and quakes like jelly when shaken (153A). The whey is drawn down until the curd begins to show above the whey surface, and the curd and remaining whey are dipped with a flat sided curd pail into wooden molds, placed on an inclined draining table, which is covered with coarse cloth or burlaps. The molds are filled to the top, and after an hour or when the curd has settled half way down the molds are turned over on the cloth and left to drain, with 3 or 4 additional turnings during the day. Board followers are placed on the curd after turning, but no weights are added.

P

The wooden, or tinned metal molds or forms are 5 inches wide, and 8 inches deep, and may be 10 or 30 inches long. They are perforated with ⅛-inch holes about 2 or 3 inches apart, or wooden molds may have the inner surface scored about ¼-inch deep, with a saw blade, forming nearly vertical grooves about ½-inch apart. The holes or grooves aid in the draining.

(192B) Salting and Curing. The next morning the hoops are removed and the block of curd is cut into 2-lb. square blocks, or oblong 1-lb. blocks. These are rolled lightly in coarse, dry salt, and piled one deep on the salting table. The second morning they are salted again and piled two deep. The third morn-

ing they may be salted again lightly (or not) and piled three deep. On the following morning they are taken to the curing

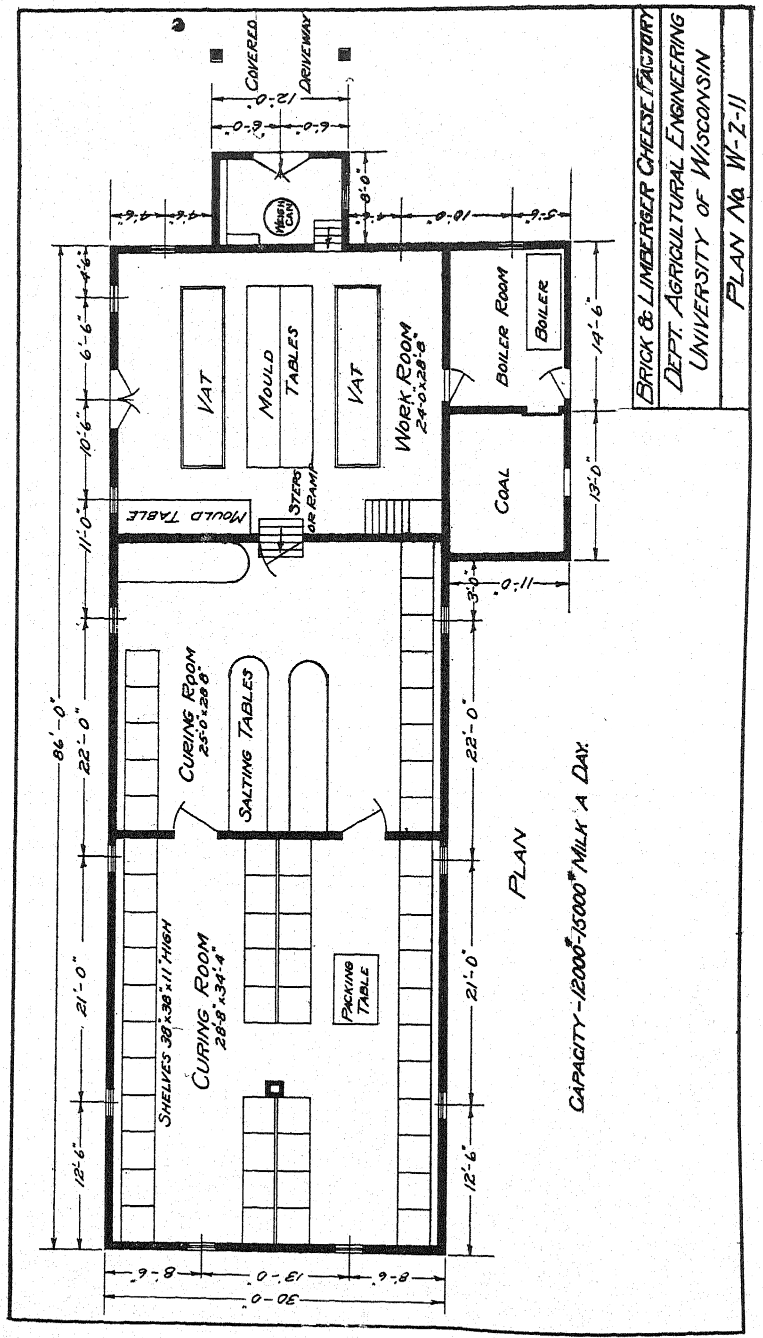


Limburger Curing Cellar. The cheese are shown on the salting table and on the curing shelves.

room and placed on the flat side, close together on shelves. The third salting is often omitted with 1 lb. Limburger, on account of their small size (137A).

The curing cellar is kept at about 60-65 degrees and at about 95% humidity. As long as they remain on the shelf, the cheese are turned over and "smeared," that is rubbed by hand, every other day and if the surface becomes at all dry, the hands are dipped in water containing a little salt. After 10 days they may be placed on edge, close together to delay further drying. Complete curing requires about 6 weeks, but the cheese may be wrapped in paper and tin foil when three weeks old, or earlier if in danger of getting too dry, and packed for shipment. After a week or two on the shelf, the surface is smooth from rubbing and turns a brownish color, while the interior begins to soften just below the rind. The curing proceeds from just below the surface toward the center until the kernel of white, crumbly curd is entirely softened and finally disappears when the cheese is fully ripe and ready to eat. Curing may be delayed somewhat in cold storage.

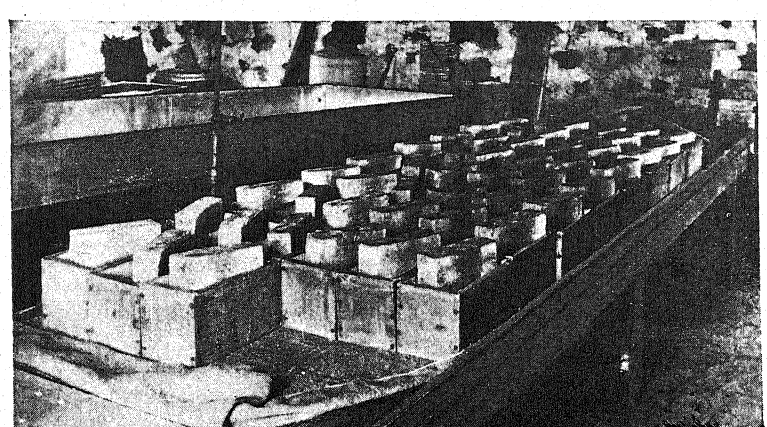
Limburger cheese is made as described above in oblong tin cheese vats, using American curd knives and having the drain-


BRICK & LIMBERGER CHEESE FACTORY
DEPT. AGRICULTURAL ENGINEERING
UNIVERSITY OF WISCONSIN
PLAN No. W-Z-11
COVERED DRIVEWAY
12'-0"
6'-0"
6'-0"
8'-0"
WEIGH CAN
4'-6"
4'-6"
10'-0"
5'-6"
VAT
MOULD TABLES
VAT
WORK ROOM 24'-0"x28'-8"
BOILER ROOM
BOILER
14'-6"
COAL
13'-0"
MOULD TABLE
STEPS OR RAMP
3'-0"
11'-0"
CURING ROOM 25'-0"x28'-8"
SALTING TABLES
CURING ROOM 28'-8"x34'-4"
SHELVES 38"x38"x11" HIGH
PACKING TABLE
86'-0"
4'-6"
6'-6"
10'-6"
11'-0"
22'-0"
21'-0"
12'-6"
22'-0"
21'-0"
12'-6"
8'-6"
13'-0"
8'-6"
30'-0"
PLAN
CAPACITY-12000#-15000# MILK A DAY.

ing table placed alongside of the vat. It is also made in round copper kettles by the same general process, using the scoop, wooden sword, and Swiss harp commonly employed with a round kettle.

Limburger cheese is quite compact, showing few if any holes on the cut surface. It contains about 45% of moisture, or more. The surface is never paraffined (137A).

(193A) Brick Cheese Making. This variety of cheese, said to have originated in America, is made much like Limburger,



Brick cheese in the forms, under pressure.

but is a little drier and slower curing and does not become creamy in consistence when fully cured. The milk used need not be so sweet as for Limburger, and mixed night and morning milk is commonly used, (U. S. Dept. Agr. 359) raw or pasteurized.

If the milk is very sweet, or tends to be gassy, the addition of about ¼ or ½ per cent of starter is desirable. Without waiting for ripening, the milk at about .16-.17% acidity is set at 86-90 degrees with 3½-4½ ounces of rennet extract per thousand pounds, so as to cut in about 30 minutes.

At 102, a lactic starter, or at higher temperatures a thermophilic coccus starter can be used. After cutting with American curd knives, the curd is stirred for about 10 to 15 minutes, and then heated slowly (in about 30 minutes) to 102 or 110-112 or sometimes 120 degrees, according to the maker's judgment.

The curd is not allowed to become as firm as for American cheese and the whey acidity should not go over .15%, but the maker watches the firmness and seldom uses an acid test. When

firm enough a handful of the curd no longer appears like a mass of quaking jelly or wet mortar when gently shaken, as for Limburger (192A), but the curd pieces are firm enough so that the whey runs out freely from among them, leaving some air spaces visible among the cubes in the handful. (See 153A). When this occurs, the whey is drawn until the curd begins to show above the surface. The curd and remaining whey are dipped out of the vat with a flat sided curd pail into wooden or metal molds (192A) of the same dimensions as for Limburger cheese and arranged on the draining table in like manner. Factories making brick cheese throughout the season, commonly use the 10-inch molds, which are placed close together on the table so that the curd from the pail runs into two molds at once. Each mold makes one brick cheese. Jumbo brick weigh 10 to 11 lbs. Daisy brick are round and weigh 20-22 lbs.

The cheese are turned with the mold, when well settled, about 10 to 30 minutes after dipping, and a wooden follower is dropped into each mold, and a 10-inch mold is weighted with one ordinary building brick, preferably with a glazed surface to prevent absorption of moisture. For a 30-inch mold, two bricks are used. Each time the hoops are turned the boards and weights are replaced.

Factories making Swiss cheese during most of the season make brick cheese usually at the beginning and end of the season, when the milk is delivered in small quantity once a day. The round kettle and its tools are used, or the square vat.

(193B) Salting and Curing. The cheese are salted on three successive mornings, the same as with Limburger cheese, and on the fourth morning they may be scraped on the edge, if necessary, with a dull knife blade to fill up and smooth the surface. They are placed on the curing room shelves (137A).

The tendency of a beginner is to salt the cheese too heavily, which causes them afterward to become sticky and slimy on the surface. With too little salt the rind is soft and thin and the cheese on the shelf will bulge and lose their shape and the flavor will be affected, by lack of salt (N. Y. Bul. 670).

Instead of dry salting, as above, brick cheese are often "brine salted" by floating in 80% brine for 2 days, and are then put on the shelf. Byers and Price (Wis. Rept. Bul. 438, 1937) recommend salting brick cheese for 24 hours in brine containing 26% salt for best flavor, but used 48 hours for best body, and 72 hours for best texture.

The curing room is kept at about 60-65 degrees, and the floor may be sprinkled with a jet of water, if necessary, to keep the air moist.

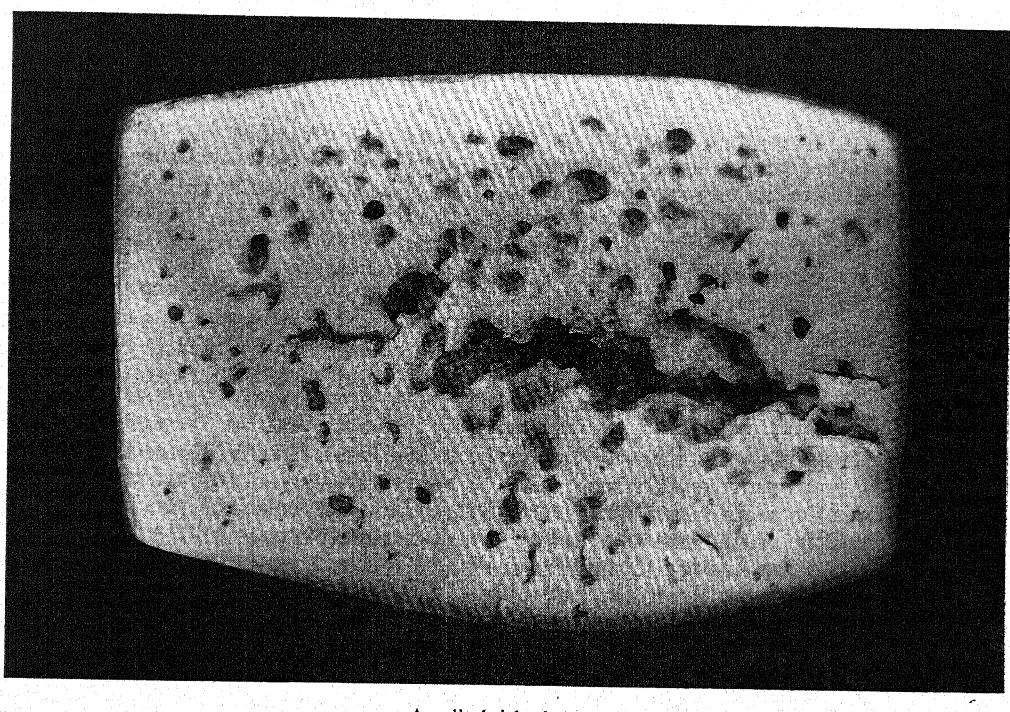
In the curing room they are washed every other day, turned and replaced on the shelf. They slowly become brownish on the surface and waxy and translucent inside as curing proceeds, but not creamy, like Limburger. For complete curing about 8 weeks is required. Cold storage delays curing.

When half cured the cheese may be allowed to dry for a day or two, after which they may be dipped in paraffine to prevent further drying out and wrapped in parchment and manilla paper, and packed in cases about 22 inches wide, 31 inches long, and 5½ inches deep, or sometimes in half boxes 15 inches long, inside measurement, or in quarter boxes.

Brick cheese are rarely wrapped in tin foil, except for shipment to a warm climate, where there is danger of excessive shrinkage through drying out unless wrapped.

Brick cheese show on the cut surface a few small holes either of irregular outline, or somewhat rounded.

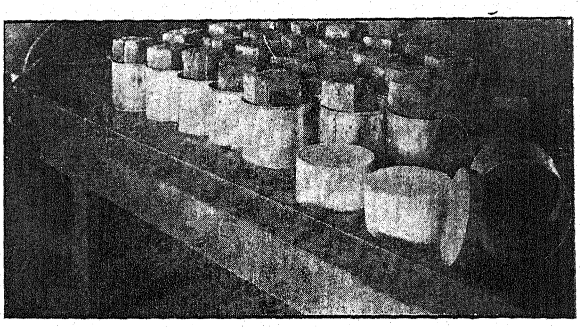
The cheese contains 40% of moisture, or a little more or less, and is thus just on the border line between soft cheese and hard cheese. The legal limit in Wisconsin is 42% plus 1% tolerance for first grade, and 43 plus 1% for second grade.



A split brick cheese.

(193C) Splitting. A serious trouble has been the splitting of cheese on the shelf. Low acidity, low salt content, and large size of cheese, together with yeasty or gassy milk or spore-forming starters, are contributing causes, according to W. V. Price, et al. Cheese held 24 hours in brine showed splitting, but those held 48 hours, below the surface, did not. The brine strength might be increased to 90%. (216). (18) (33) Wis. Bul.

(194) Muenster Cheese. The curd is made in about the same way as for brick, but the cheese forms are round, made of

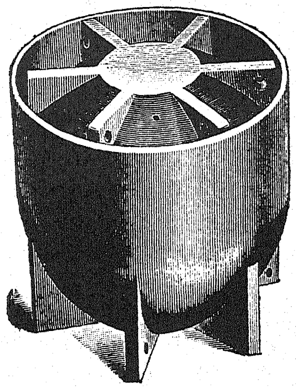


Muenster cheese in hoops on the press table.

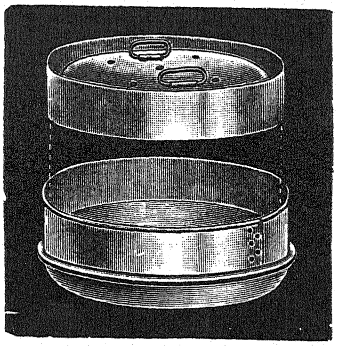
sheet metal and perforated. The cheese are salted like brick cheese, but must be kept on one of the flat ends, and wooden blocks are often used between the cheese on the salting table to keep them in the proper shape, while developing a rind. By salting in brine it is easier to keep them in shape. In 1941 the moisture limit was 43% plus 1% tolerance, in Wisconsin. If of higher moisture content, cheese must bear a special label. No skimming is allowed. A 3 day holding order is in force. They are never paraffined, but are often dipped in dilute cheese color to darken the surface or dipped in clear, odorless paraffine oil, before packing. "Block Muenster" is shaped like brick cheese, but high in moisture.

(195) Edam Cheese. In northern Holland, Edam cheese are made in round kettles and tubs. The method used for making Edam cheese in the United States resembles closely the method of making American cheese by the granular process (231), except that the cheese is well colored by adding 1 to 1½ ounces of cheese color to the milk, and subsequent treatment is different. Edam hoops are used, and the cheese is salted on the outside.

(The curd is well firmed in the whey, and well stirred in the vat,) after drawing the whey, and may be salted lightly in the granular form. The Edam cheese molds are lined with strips of



Edam Cheese Mold made of cast iron, or wood.

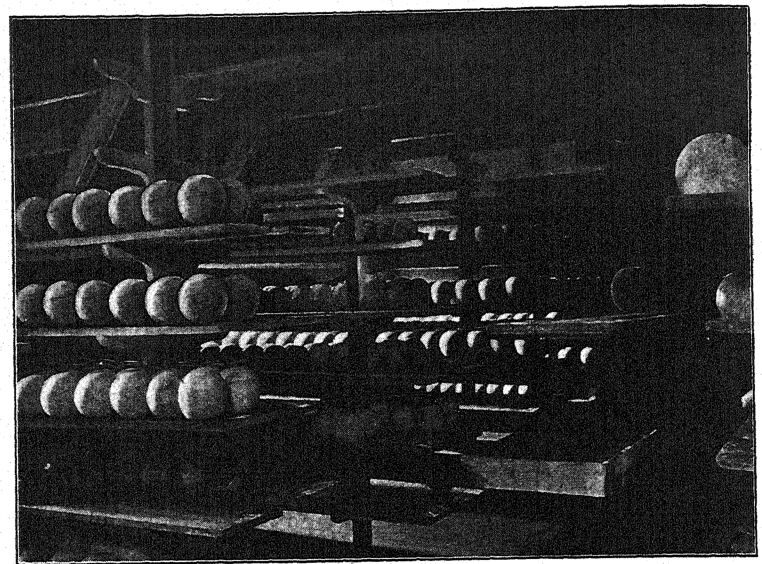


Gouda Cheese Hoop.

cheese cloth and well filled with the granular curd, so that after pressing, the cheese will yet fill the hoop, and not allow the base and the cover to rest on each other. After pressing for a half hour or more in the gang press used for Young American cheese, the cheese are taken from the hoops, any rough places trimmed off, and dipped for about two minutes in hot whey at about 125 degrees. They are then wrapped again completely in the cheese cloth strips, and returned to the hoops and left in the press over night.

The next day, the cheese are examined, and if the rind is perfectly closed, they are ready for salting. This is done by rubbing dry salt over the entire surface, and placing the cheese in the salting hoop, which has a small drain hole in the bottom. A small handful of dry salt is placed on the upper surface, and left uncovered until next day. The cheese are then turned over in the mold and the other side salted, and this is repeated for 4 or 5 days. Finally, the cheese are washed with whey, wiped dry, and placed on the curing room shelf. The air should be quite moist to prevent the rind from drying out and cracking, and the temperature at about 60-65 degrees F. The cheese are turned daily, may be washed to keep the surface clean and prevent cracking. When the surface is well dried, but before they begin to crack, they are colored a dark red by dipping in a red dye, which can be bought in the market. After standing again on the shelf until the surface is well dried, they are dipped in hot paraffine, and packed for shipment.

Using half-skimmed milk in Holland, a rather dry, and well salted cheese is produced. Instead of paraffine, the cheese may be rubbed with boiled linseed oil, or a sugar solution, which is applied to the salted and partly cured cheese to prevent cracking



Edam Cheese on the curing room shelves in Holland.

of the rind, and the red color may be applied later by dipping in an alcoholic solution of carmine or Berlin red. They are sometimes covered with tin foil or sealed in tin cans for export.

(196) Gouda Cheese. These are made in south Holland, and have the shape of a flattened ball or sphere. The cheese is made from sweet milk, cutting the curd very fine, and firming well in the whey. The whey is then drawn, and the curd pushed to the upper end of the vat with a strainer board, and left to mat. The matted curd is later cut into square blocks, one of which nearly fills the Gouda hoop. After pressing, the cheese are salted in brine. They are made in several sizes. A very few factories in Wisconsin have made Gouda cheese. Rhodesia Agric. Jrnl. 1924. p. 269.

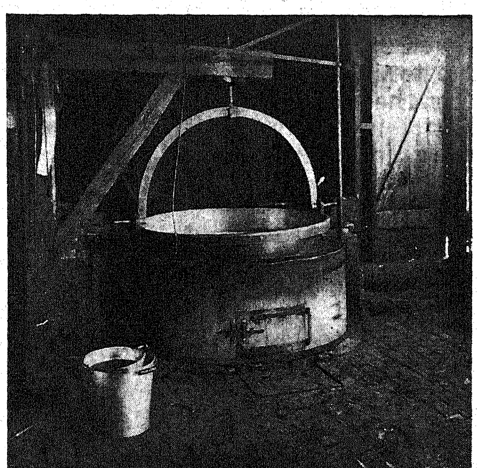
(196A) Grades and Marks. These Holland cheese, as well as other European varieties, are often made in four grades as to fat content, either "Volvet" (full cream), or containing 40, 30, or 20% fat in the dry matter. "Cheese marks" printed on thin sheets of casein are pressed into the cheese surface, as a guarantee of quality, by the Dutch Cheese Association.

CHAPTER XXVI.

Hard, Ripened Rennet Cheese

(197) **Swiss Cheese.** In making this and all other kinds of hard cheese, the curd is heated and well firmed in the whey before the curd is put into hoops. Swiss cheese is often called the king of cheese, from its large size, fine flavor and the remarkable appearance in the cut surface of the round holes called "eyes."

(197A) **The Milk Supply for Swiss Cheese.** Milk for Swiss cheese was regularly brought to the factory both night and morning, fresh and warm from the cow, and made into cheese



Early Swiss Kettle with crane and jacket.

without delay, twice a day. It is more often made once a day, from mixed night and morning milk. For this purpose, the night milk must be kept clean and cooled quickly, on the farm, or sometimes at the factory, and kept cool over night (6G).

Milk inspection should be carefully done (10). Abnormal, overripe or unclean milk is especially harmful in making Swiss cheese. Pasteurized milk has been tried at times, with the addition of eye-former starter. (203).

Data on over 500 cheese at 20 factories in Ohio and Wisconsin, collected by Sanders, Farrar, Feutz and Hardell (B.A.I., U.S.D.A., Jrnl. Dairy Sci. 1941, vol. 24, 639-648) showed that when the methylene blue reduction time was 3 hours or less,

there were more than twice as many cheese in the undergrades as in the A and B grades; when the reduction time was over 3 hours the results were reversed, with nearly twice as many in the A and B grades as in the undergrades.

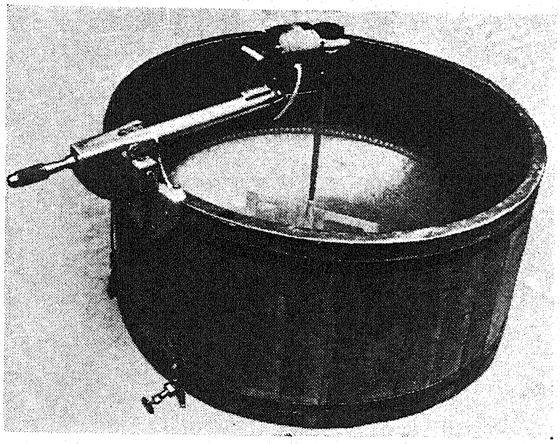
If the methylene blue reduction time on the kettle milk is not over 3 hours, the chances are about one in three that the resulting cheese will be of the A or B grade. If the reduction time is over 3 hours, 2 out of 3 cheese may be expected to be of the A or B grade.

The chances of making an A or B grade cheese may be increased to three out of four, by adjusting the starters and the making process to a pH at dipping above 6.35 and not over 6.51. If the pH at this time is over 6.51 there is only one chance in 8 or 10 that the cheese will be of the A or B grade. (40)

It is highly probable that when the pH at dipping goes as low as 6.30 or even 6.20, as it frequently does under factory conditions, it is due to an active thermophilic coccus which develops even during the cooking process, and that the defective cheese may be attributed directly to the abnormally high acidity. (See also Jrnl. Dairy Sci. 21: 172, 1938).

(197B) The Swiss Making Process and Tools. A round copper kettle holding 2,500 to 3,800 lbs. is used, to permit easy dipping of the curd. In the past it was hung on a crane, and heated over an open fire, but the building soon became blackened by the smoke. The kettle and fire were therefore surrounded by a movable jacket, connected to a chimney, and provided with a cover to retain smoke when the kettle is swung away. Later, the kettle was set permanently in brick work, and heated from below by a movable fire wagon on a little track below the floor. The latest method is to heat the kettle by steam in a wooden jacket. Every factory should have a steam boiler for making starter, steaming cans and milking machines, steaming whey in the tank, heating the curing room, to heat the kettles, and to run the clarifier and separator.

The special tools used in working about the round kettle include the Swiss harp for cutting curd, the "breaker" for stirring often operated by power, the steel strip or "boegli," the square linen cloth with which the curd is dipped out of the whey, the special hoops, press, and the scoop made of wood or metal. The scoop is used for stirring the kettle contents, either milk or whey, either in a horizontal circle, around the kettle, or in a vertical circle, called "turning over" which is done by rapidly and steadily pulling the curd or milk across the top of the kettle from the far to the near side.



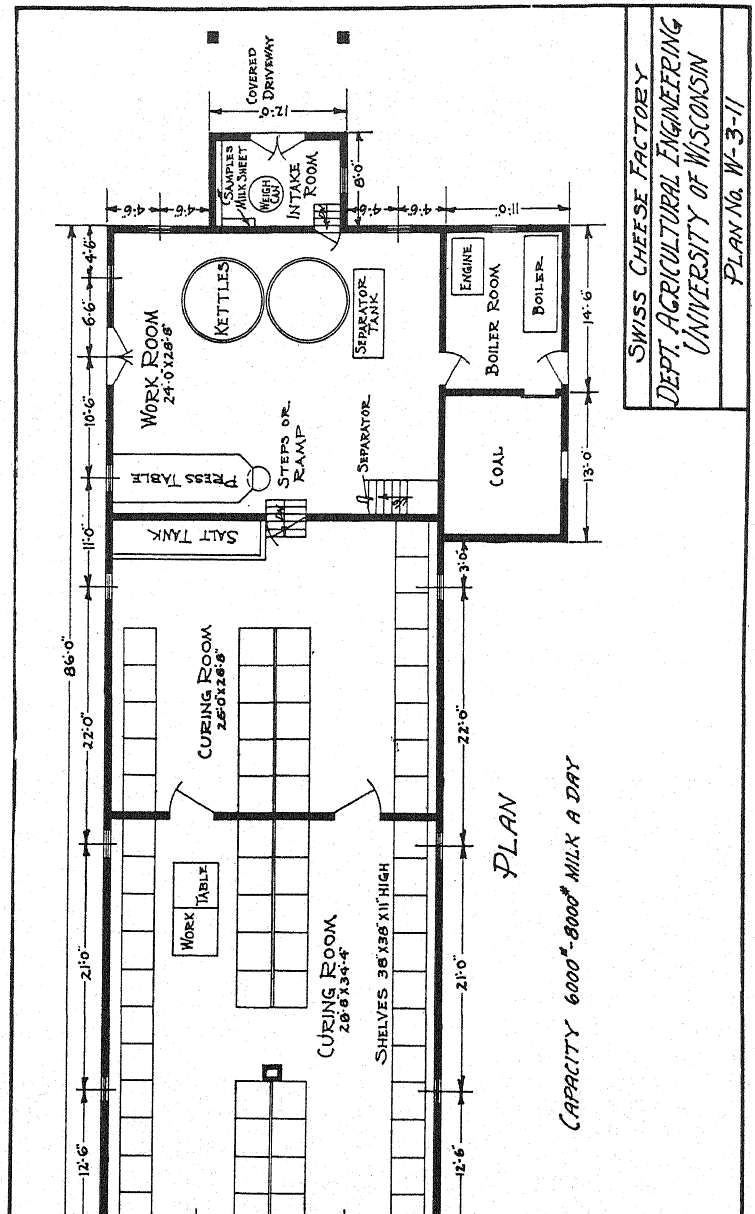
Modern Kettle and Stirrer.

A few factories are also provided with a milk holding room, containing a trough for cold water, in which large pans of milk are set in the morning to ripen slightly during the day for use in the night kettle, etc. With the water at 50 F., pans of milk at 75 F., or 80 F., set in the water, will cool to 60 F., and ripen a little. One-tenth to one-quarter of the milk may be thus held over, but good milk only should be held in this way. This, like the use of starter, tends to check gassy cheese, and helps to get the curd firm, in the whey.

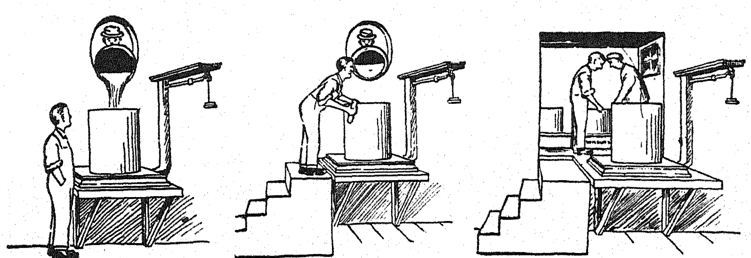
(197C) Why Factories Run Twice a Day. Where all the night milk is cooled properly at home by the farmers, and brought to the factory in the morning, factories are making once a day with success. If some of the night milk is not properly cooled, and either gassy or overripe as a result, the proportion of ripe milk would often be too large in the kettle, and sour, blind cheese would result. For this reason some Swiss or Limburger factories insist on having milk delivered twice a day, fresh and warm from the cow.

In addition, where cheese is made twice a day, one 3,000 or 2,500 lb. kettle will suffice to handle 5,000 lbs. of milk daily, but two kettles would be needed, if used only once a day. For these and other reasons, some small Swiss factories make twice a day, although this makes very long hours for the daily work.

(198) Swiss Cheese Factory Buildings. As Swiss cheese are commonly cured 3 to 8 months at the factory at different


SWISS CHEESE FACTORY
DEPT. AGRICULTURAL ENGINEERING
UNIVERSITY OF WISCONSIN
PLAN No. W-3-11
COVERED DRIVEWAY
12'-0"
SAMPLES
MILK SHEET
WEIGH CAN
INTAKE ROOM
8'-0"
KETTLES
SEPARATOR TANK
ENGINE
BOILER
BOILER ROOM
WORK ROOM 24'-0"X28'-8"
STEPS OR RAMP
SEPARATOR
PRESS TABLE
COAL
SALT TANK
CURING ROOM 26'-0"X26'-8"
WORK TABLE
CURING ROOM 26'-8"X34'-4"
SHELVES 38"X38"X11" HIGH
PLAN
CAPACITY 6000#-8000# MILK A DAY
86'-0"
4'-6"
6'-6"
10'-6"
11'-0"
22'-0"
21'-0"
12'-6"
14'-6"
13'-0"
3'-0"
11'-0"
8'-6"
13'-0"
30'-0"

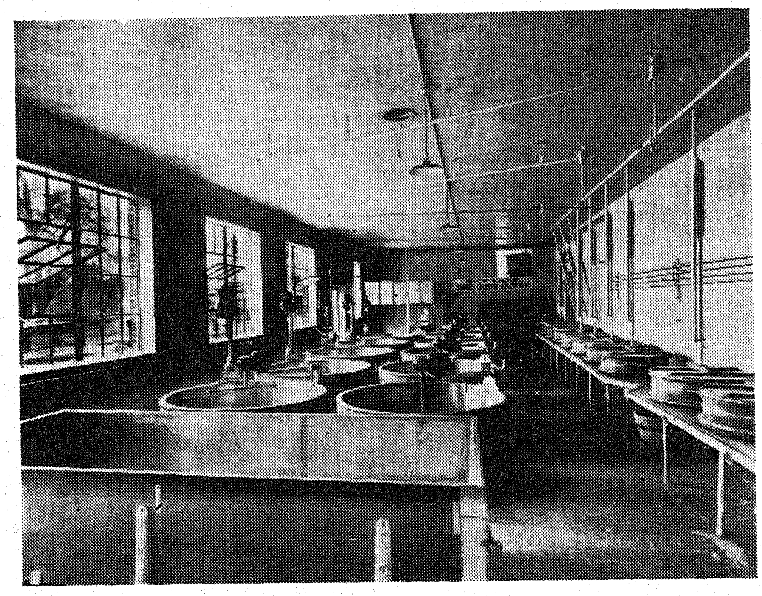
temperatures, first lower, then higher, the curing rooms are generally cellars, and much larger than the make room. At least one cool room and one warm room must be provided, and larger factories have three separate curing rooms at different temperatures. The location is usually at the side of a hill, with the make room on the level of the road, for convenient milk delivery, and the curing cellar in the ground and two to six steps lower. The living rooms or a roof built over the cellar protect it from heat and cold. The earth surrounds the cellar walls up to a foot below the ceiling. A few small windows admit light and occasional ventilation. The cellar walls are most frequently built of stone, the floor of concrete, and the ceiling of wood, or concrete, well insulated and air tight. The cellar may be 10-12 feet high, whitewashed all over inside, and divided by tight partitions of wood or stone. The brine tank may be made of wood, but much better of concrete. Floor drains in every room, well pitched floors, a separate partitioned-off boiler room, and a good intake room are essential for every factory.



(199) The Intake. This has been neglected at many Swiss factories, consisting simply of a hoist for milk cans, and a small hole high up in the wall, through which the patron dumps the milk from the can. The maker standing on the floor below has no chance to examine the milk before it is dumped, unless he goes out on the wagon, which is likely to excite the wrath of the patron and the comment of other patrons who are waiting near by. Much poor milk was received and poor cheese manufactured as a result of this unsatisfactory intake system.

To remedy these conditions, the simplest way is to build a small set of steps inside the factory, so that the maker can go up along side of the weigh can, and examine each can of milk before it is emptied, without attracting special attention outside the factory.

The best way is to build a covered intake platform or intake room, such that the maker and patron can work together unloading the cans of milk, inspecting it, and dumping it, and thus any can of milk can be discussed with the patron, and even put back on the wagon in the same manner as an empty can (9) (89). A small hole for the conductor spout and a glass window above it, enable the maker to see when the kettle is full, and keep flies out of the factory. After the intake is used and scrubbed, the outside doors may be closed and locked until next time. It contains the milk sheet, and the composite sample bottles on shelves, besides the weigh can and scales.



Swiss Cheese Make Room.

(200) The Make Room contains the row of kettles and stirrers in front of the intake, the whey separator, clarifier, and whey skimming tank of tin near by. The cheese press tables are located opposite the kettles. In front of a window on a table or shelf is placed the acidimeter, in a good light. The methylene blue milk test incubator, and the steam sterilizer or steam table and jacket and incubator for starter, may be in the corner near the boiler room.

(201) **The Curing Cellars** contain shelving for Swiss cheese, which may be taken down at the close of the season to be washed, and dried in the sun. The space for each cheese is 38 inches square and 10 to 13 inches high. The risers are of 2 inch material and the boards about 1 inch thick. The shelves extend from floor to ceiling along both walls the entire length of the room, and often two rows down the middle of the room.

The back room, farthest from the make room, or one of the rooms, is provided with a chimney, which also serves the family living room above. A stove in the cellar room, often with a large water pan on top to provide moisture in the air, and a jacket around the stove to direct the heat upward away from the nearest shelves, serves to heat this warm curing room, in which the cheese are placed to "open."

Some factories keep the air moist and the room warm by placing a tank in one corner about 2½ feet in diameter and six feet high (2-barrel kerosene tank) full of water, kept hot with a steam pipe, provided with a check valve, from the boiler running into the water. Some factories have steam radiators for warmth and a water spray for moisture, or let some steam escape into the room.

The salt brine tank of concrete or sometimes of wood is placed in the first curing room, just inside the door from the make room. This room also contains shelving for cheese taken from the brine tank, or while dry salting. The salt barrel stands near the brine tank. A separate cold room also holds cheese after they have been through the warm room, until packed for shipment.

The carpenter shop for building cheese tubs is located upstairs over the make room or the first curing room, and serves as a general storage room for salt, lumber, scale boards, etc.

Thermometers should be hung in each of the curing rooms, for daily observation.

Convenient plans for Swiss and other cheese factories are issued by the Agricultural Engineering Department, Wisconsin College of Agriculture, Madison, Wis.

The dimensions of a moderate sized two kettle Swiss factory may be 90 or 100 feet long by 30 or 40 feet in width. The whey tank, replacing the old time whey barrels, should have a steam pipe running directly from the boiler. Daily occurrence of badly bloated cheese has been entirely stopped by steaming the whey in the tank twice a day (220E). N. Y. Geneva Bul. 412.

(202B) Pure Cultures for Swiss Cheese Starters. For a long time, pure culture lactic starters, grown in milk have been used for American cheese. More recently, the old Swiss "sour" and "lab" have been replaced with pure culture starters of Bulgaric bacteria (18) grown in milk (or sometimes skim milk), or in whey in a few factories. See address by J. M. Sherman, Ph. D., bacteriologist, Dairy Division, U. S. Dept. of Agriculture, at the 1923 International Dairy Congress, Syracuse, N. Y. "The Use of Bacterial Cultures for Controlling the Fermentation in Emmenthal Cheese." Also Journal of Bacteriology, Vol. 6, page 379-390; Journal of Dairy Science, 16 (1933), p. 387. These cultures can be obtained from the Dairy Bureau at Washington, or from the Wisconsin Station at Madison, or from dealers.

Beginning with strictly pure cultures of Bulgaric, it was soon found that these bacteria grew faster and lived longer, if the culture contained also the "gray mold" which often grew on the surface of "lab" and "sour."

In 1932, R. E. Hardell reported (Amer. Cry. and Poultry Prod. Rev., Vol. 74, pp. 244, 245) that the use of Bulgaricus starter alone does not prevent dead eyes, defective body and texture, or "stinker" cheese Adding also a pure culture, or even raw whey, containing thermophilic streptococcus improved the body, texture, and grade of cheese. The streptococcus starter aided in firming the curd in the kettle, while the pure culture Bulgaric did not. Later, it was noted that starters, made with bulgaric (rod) cultures, contained also large numbers of the (round) thermophilic coccus bacteria, apparently introduced by using the kettle thermometer to test the temperature of the starter milk. At present, the laboratories therefore supply pure cultures of the rod and coccus forms separately, which can be grown separately in two starters, to be mixed in the kettle, or can be grown in one mixed starter, the proportions of rod and coccus in the growth being controlled by the temperature of the incubator, between 92 and 102 F. At the higher temperatures, the rods are more abundant in the growth, but at the chosen lower temperature (perhaps 96 or 98) there are more coccus forms than rods, (about four rods in a microscope field) when added to the kettle. An all-glass thermometer is thoroughly sterilized for use instead of the kettle thermometer. It is said by some investigators that the bacteria grow faster in the mixed culture than they do in separate cultures.

Pure Cultures Furnished to Factories. In recent years, the College of Agriculture, Madison, Wis., has furnished Culture No. 1, a rod culture, called "39A."

Culture No. 2 is a rod culture, (with a mycoderm or gray mold, to keep the culture active) called "Gere A" or "Hardell"

culture. This develops acid sooner in the cheese in the press than does culture No. 1.

Culture No. 3 is a coccus, with mycoderm.

Culture No. 4 is a mixed rod and coccus culture, a mixture of either culture No. 1 or No. 2 with No. 3.

Culture No. 5 is the "eye-former" or flavor producing culture.

Cultures Nos. 1, 2 and 3 have been used by many factories in Wisconsin for a number of years with success. A smaller number of factories have used the mixed rod and coccus culture, No. 4. It is believed that a cheesemaker will be most successful when he prepares two starters each day, one of the rod and one of the coccus. He can then use in his kettle milk as much of each as he thinks best, under his conditions.

It is recommended to secure fresh cultures from the laboratory each week.

Most factories need to add a starter of rod bacteria to the kettle of milk. Some factories seem to have enough coccus bacteria in the kettle milk, and do not need to add coccus. Most factories need to add some coccus, but the amount varies at different factories, and with the time of year, etc. anaerobic propionic acid

The "eye-forming" bacteria (18) need not be added to most milk in order to get eye formation in the cheese, but the use of this starter improves the flavor. Too much may cause oversetting. A circular accompanying the cultures further describes their handling and use.

C. A. Buck, Monroe, Wis., reports from the Cheese Laboratory that over forty makers now are using separate milk cultures, to be mixed in the kettle. As a rule the Bulgaricus alone, grown in milk, develops 1.0 to 1.3% acid, but occasionally 1.7% 1.1 to 1.3% is preferred. The thermophilic coccus pure culture, grown alone in milk, develops .6 to 8% acidity.

Mixed cultures in milk vary considerably. They develop .8 to 1.2% acidity, but at .8% usually very few Bulgaricus rods are seen; while above 1.0% acidity the coccus usually does not exceed half of the bacteria seen in the microscope field.

During the first few hours in the kettle and press, the coccus produces the acid necessary to give the curd the desired "grip," and the bulgaric produces more acid later in the cheese. (Jour. Dairy Science (1935) 731.) (U. S. Dept. Agric. Yearbook 1934, p. 340.

(202C) Making New Starter Daily. The maker needs first, the necessary training and skill to sterilize milk, and keep it

sterile, and to transfer cultures and keep them pure, by avoiding contamination. Sterilization of milk has been described (28A, B).

Having received from the laboratory a bottle of pure culture, 2 drops may be transferred to a bottle or small glass jar of sterile milk, and incubated over night, thus to make a "mother culture."

Eight drops of mother culture usually is enough to inoculate a gallon of sterilized milk to be incubated over night, and used next day in the kettle.

Many makers now inoculate the starter milk at 110 degrees and place it immediately into the incubator at 92 to 96 degrees.

Inoculating at 3 P. M., for use at 6 A. M., allows 15 hours for growth of the starter, according to common practice. (25A).

Many makers now use 1 pint of starter to a kettle of milk, but a few use 1 or 1½ quarts. The starter may be added to the kettle at any time, before or after taking in the milk. All the above relates to milk starters. The laboratory bottle may be kept for a week or two (not in the incubator) and 2 drops taken each day to make a new mother culture; or each day the 2 drops may be taken from the mother culture made yesterday, discarding the laboratory bottle after the first transfer out of it. A new laboratory bottle of culture is received every week, or two weeks.

The incubator box, to hold jars of growing starter, and equipped with electric light bulb for heating, and thermostat for automatic temperature control, is now considered indispensable in any Swiss factory.

(202D) Whey Starters for Swiss Cheese. Whey starters are used extensively, and they vary greatly in method of making, and in bacterial content. Whey may be taken from the kettle soon after cutting curd, and before cooking; most often just before or after the cheese is dipped, or after separating. The whey is usually heated up to 45 or as high as 60 R. (135-167 F.) and set immediately into the incubator to cool. The higher the temperature of heating, the lower the acidity development, and the smaller the percentage of bulgaricus (rods). Usually when heated above 54 R. (153-5 F.) the rods will disappear entirely, or almost. This may develop .3 to .7% acidity. It may be inoculated after cooling, if desired, with culture or with "sour" from the day before.

In the old "scheiden" process, sweet whey is taken from the kettle, and heated immediately to 190 degrees F. The addition of dilute acetic acid or sour whey curdles the albumen, which slowly rises to the top, and the clear green whey is drawn out

below through a faucet. This is cooled, inoculated with a larger proportion of culture than used with milk, and left in the incubator over night. The acidity goes up to about .5 or 1.0%, when added to the kettle. It is necessary either to make an entirely fresh starter every day, or else to discard most of the liquid, and add fresh, heated and cooled whey, to keep the bacteria alive and growing.

(202E) **Whey Rennet, Lab, etc.** The old time "lab" made at home from calf stomach and whey (61) is now quite generally replaced by commercial rennet extract, on account of its uniform strength, and its freedom from bacteria.

(202F) **Acidimeter Tests.** The acidimeter tests of importance to the Swiss cheese maker are for fresh, sweet milk usually about .14-.16%; for milk held over, cool, about .16-.17%; for milk held warm, .20 or higher; for lab .4-1.3%; for press drippings five hours after dipping about .7%; for ripe whey bulgaric starter .3-.7%; for ripe bulgaric milk starter, 1.0-1.3%. In comparing the acidimeter with the Swiss saeure-probe, the acidity percentage multiplied by 40 gives the saeure grade, Swiss: .15% equals 6. degrees, Swiss.

(203) **Inspection and Grading of Milk.** Too much attention can not be given to the inspection of milk, and the selection of suitable milk for Swiss cheese manufacture. The methylene blue test helps the maker to judge the quality of milk from each patron. The sediment test helps the maker to teach cleanliness to the patrons. The maker should inspect and smell every can of milk at the intake. (17G)

(203A) **Eye Forming Starter.** The eye former bacteria are present in ordinary whey rennet, grown at about 86 degrees, but pure culture may be used in addition. This germ grows well in cheese at the temperature of the warm curing room. (18)

(204) **Clarification of Milk.** See address by K. J. Matheson, dairy manufacturing specialist, U. S. Dept. of Agriculture, at the 1923 International Dairy Congress, Syracuse, N. Y. "New Developments in the Manufacture of Swiss Cheese," describing the centrifuging of milk for Swiss cheese.

Clarification has been used at a number of the leading Swiss cheese factories, and excellent results claimed for it, in producing fewer and larger "eyes" in Swiss cheese. The reason for this seems to be connected with the removal of leucocytes. Milk from mastitis-affected cows gives overset Swiss cheese, but clarification prevents this trouble. Rept. of Bur. Dairy Industry, 1936, page 7; Michigan Tech. Bul. 84 (1927). Clarification by run-

ning milk through a milk separator, and mixing the skim milk and cream, as well as by the use of the clarifier has been tried, but the latter is claimed to cause less loss of fat in the whey.

Clarification of warm, sweet milk causes much foam, but this can be reduced by first cooling milk to 65 F., as with mixed night and morning milk, or by use of a foam preventer attachment on the clarifier, or by reducing the speed in some cases.

(205) Standardization of Milk for Swiss Cheese. The proportion of fat to casein is well known to be somewhat larger in normal high testing milk, as from Jersey cows, than from lower testing milk. Experiments at the Wisconsin Station showed the average fat and casein contents to vary as follows:

Milk fat test, %	3.0	3.5	4.0	4.5	5.0
Milk casein test, %	2.13	2.29	2.42	2.55	2.68
Ratio, 1 to	.71		.60		.53

In Swiss cheese manufacture, it has been believed for many years, that too much fat in the cheese gives a short texture, glass, or small, irregular eyes, somewhat resembling the effect of too much acid. In Switzerland, the

milk of test %	3.4	3.6	3.8	4.0
is reduced by standardization to about				
kettle test %	3.0	3.15	3.3	3.4

(Peter, Anleitung zur Fab. 1930 edition, p. 120).

The Wisconsin law since 1927 permits standardizing milk for Swiss cheese (69).

The new 1937 Wisconsin law provides that domestic Swiss cheese shall contain not less than forty-five per cent of milk fat in the water-free substance, with a tolerance of two per cent, so that in no case shall the fat content fall below forty-three per cent; provided that such tolerance shall not be effective unless and until the federal bureau of standards provides a like tolerance for cheese.

In factory practice, the mixed milk in the kettle tested for fat by the Babcock test shows what the average fat test is.

The casein test of the milk can be quickly made by the Walker (25) method, where a factory has an acidimeter in use. A paper by K. J. Matheson and S. A. Hall, U. S. Department of Agriculture, read at the 1922 Wisconsin Cheese Makers Convention recommended the use of the casein test every day or two, and the running of a sufficient proportion of the milk through the separator, returning the skim milk to the kettle, to reduce the ratio of casein to fat in the milk to the chosen figure which may be .68, .70, or .72.

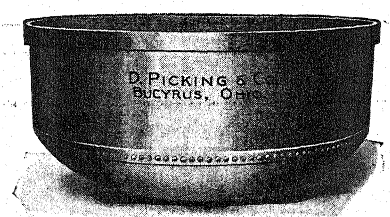
It is possible also that some vats of milk might contain too much casein and not enough fat to make lawful cheese, and thus require the addition of some cream, or removal of some skim milk. The details of the standardizing process are described in (72F).

(205A) Relation of Fat to Quality. Tabulations of analytical and commercial grading data on 844 factory Swiss cheese show that the highest average quality was found in cheese containing from 45 to 46 per cent of fat in the dry matter.

Tabulations on 30 pairs of laboratory cheese indicate that when the body of the cheese was relatively firm the presence of a slightly higher proportion of fat tends to improve the quality.

For efficient standardization it is suggested that, in each factory, the milk in each kettle be tested and standardized; that, for control purposes, pressed samples of kettle curd be secured frequently and analyzed for percentage of fat in the dry matter; and that similar analyses be made frequently on samples of cured cheese. (Jrnl. Dairy Science, Aug., 1941, vol. 24, 639-648. From B.D.I., U.S.D.A., by Sanders, Farrar, Feutz, and Hardell).

(206) Work at the Swiss Cheese Kettle. With the milk in the kettle selected (203), standardized or not (205), clarified



Modern Swiss Kettle.

(204), the use of the acidimeter shows whether any unusual acidity is present, and the addition of starter diluted with 2-3 volumes of cold water is made, best through a metal strainer, while stirring the milk well. Eye forming culture, if used, is added at the same time. The milk is then heated to the setting temperature and allowed to stand quiet for a few minutes, until the jacket of the kettle has given up its extra heat. Whey rennet (61) or rennet extract (54) diluted in several volumes of cold water is then stirred into the milk, best by the "turning over" motion (197B) of the scoop. Some makers insert the whole arm with the scoop to the bottom of the kettle of milk and stir up from the middle of the bottom, which may cause infection of

the milk from the arm. Pure well water, or else condensed steam should be used in the milk. To avoid splits in curd, see that rennet is uniformly mixed in.

As soon as possible after the rennet is thoroughly mixed in, the motion of the milk is quieted with the scoop, which is then left floating on the milk, to detect its motion, if any. The light wooden cover is put on the kettle to keep the milk surface from cooling unnecessarily, and the time of adding rennet is recorded in the note book with the other details of setting. Avoid steam leaking into the jacket. The proportion of rennet used is such as to give a satisfactory coagulation of the milk in 25-30 minutes. Uniformity of temperature and uniform distribution of rennet during setting are of the greatest importance.

(207) The Temperature of Setting Milk. The most suitable temperature is usually about 93-95 degrees Fahrenheit, 27-28 degrees Reaumur, or 34-35 degrees Centigrade. These three thermometer scales are used in different countries, Swiss cheese makers generally using the Reaumur thermometer, or a thermometer having both Reaumur and Fahrenheit scales. The calculation of temperature from one scale to another is easily done by means of the formulas.

(F-32)X4/9 equals R.	(R.X9/4) plus 32 equals F.
(F-32)X5/9 equals C.	(C.X9/5) plus 32 equals F.
RX5/4 equals C.	C.X4/5 equals R.

Thermometers Compared.

Fah.	Cen.	Reau.	Fah.	Cen.	Reau.	Fah.	Cen.	Reau.
212.	100	80.	150.8	66	52.8	89.6	32	25.6
210.2	99	79.2	149.	65	52.	87.8	31	24.8
208.4	98	78.4	147.2	64	51.2	86.	30	24.
206.6	97	77.6	145.4	63	50.4	84.2	29	23.2
204.8	96	76.8	143.6	62	49.6	82.4	28	22.4
203.	95	76.	141.8	61	48.8	80.6	27	21.6
201.2	94	75.2	140.	60	48.	78.8	26	20.8
199.4	93	74.4	138.2	59	47.2	77.	25	20.
197.6	92	73.6	136.4	58	46.4	75.2	24	19.2
195.8	91	72.8	134.6	57	45.6	73.4	23	18.4
194.	90	72.	132.8	56	44.8	71.6	22	17.6
192.2	89	71.2	131.	55	44.	69.8	21	16.8
190.4	88	70.4	129.2	54	43.2	68.	20	16.
188.5	87	69.6	127.4	53	42.4	66.2	19	15.2
186.8	86	68.8	125.6	52	41.6	64.4	18	14.4
185.	85	68.	123.8	51	40.8	62.6	17	13.6
183.2	84	67.2	122.	50	40.	60.8	16	12.8
181.4	83	66.4	120.2	49	39.2	59.	15	12.
179.6	82	65.6	118.4	48	38.4	57.2	14	11.2
177.8	81	64.8	116.6	47	37.6	55.4	13	10.4
176.	80	64.	114.8	46	36.8	53.6	12	9.6
174.2	79	63.2	113.	45	36.	51.8	11	8.8
172.4	78	62.4	111.2	44	35.2	50.	10	8.
170.6	77	61.6	109.4	43	34.4	48.2	9	7.2
168.8	76	60.8	107.6	42	33.6	46.4	8	6.4
167.	75	60.	105.8	41	32.8	44.6	7	5.6
165.2	74	59.2	104.	40	32.	42.8	6	4.8
163.4	73	58.4	102.2	39	31.2	41.	5	4.
161.6	72	57.6	100.4	38	30.4	39.2	4	3.2
159.8	71	56.8	98.6	37	29.6	37.4	3	2.4
158.	70	56.	96.8	36	28.8	35.6	2	1.6
156.2	69	55.2	95.	35	28.	33.8	1	.8
154.4	68	54.4	93.2	34	27.2	32.	0	.0
152.6	67	53.6	91.4	33	26.4			

In some cases, the setting temperature may be lower, down to 88 F., 31 C., or 25 R., and sometimes as high as 99 F. (30 R.).

The setting temperature is of importance particularly in relation to the cutting of the curd which follows. At the higher temperature, the milk thickens quickly, the curd soon becomes quite tough, so that cutting is harder to perform, the harp must be worked faster, and the curd cubes may become hard on the surface, which tends to interfere with whey separation and with even setting of eyes. A lower temperature makes the curd harden more slowly, makes cutting somewhat easier, and tends to retain more moisture and dissolved sugar, etc., in the cheese, and thus cause too much fermentation. 25°-30°

The higher temperatures are generally used with full fat milk, and with very sweet milk, and the lower temperatures with partly skim milk or overripe milk. With good quality milk, some makers prefer to set at about 28 degrees R., and soon after the curd has been cut, heat up the kettle to about 30 degrees. Whichever plan is adopted, the temperature should be watched, kept up to the chosen point, and not allowed to cool off by neglect, after cutting.

(208) Addition of Water to the Kettle Milk. Some makers add clean water to the milk in the kettle before adding rennet. Not more than 75 to 125 lbs. of water should be used in a 2,500 lb. kettle, and generally less or none at all. The well water must be pure, or else obtained by condensing steam. The addition of water makes the milk thicken more slowly to a softer curd, much as if a lower setting temperature had been used.

Water addition also increases the volume of the whey and the loss of fat and milk sugar in the whey. It makes the curd more elastic, and also the cheese, and on this account, is often used to prevent glass. Too much water may reduce the flavor of the cured cheese.

(209) Time of Thickening. This should be normally 20 to 30 minutes, most commonly about 25 minutes. With overripe or gassy and sour milk, the thickening should not be delayed, as this permits the trouble to increase. To judge when the curd is ready to cut, various methods are used. The maker may lay the back of his hand on the curd surface, press down quickly once or twice, and note how far the ripples run across the surface of the curd, also how much resistance the curd offers to the pressure. The wooden scoop stood upright and edge down in the curd should turn over slowly. The curd when well thickened should stretch a little and break away clean from the kettle when pulled, also the bottom of the wooden scoop when lifted should be clean and free from curd. When broken with the finger, the

curd gives a clean smooth break, with yellowish white whey in the break, not white, nor green (255). The curd should be firm enough to cut into well formed cubes, not dust.

(210) The work of cutting and stirring the curd may be carried on in several different ways to accomplish the same results.

Where the kettle was not covered during thickening, the surface layer may be cooler and softer than the lower parts, and the surface is often turned over with the scoop, to the depth of about half an inch, in order to warm up again the top of the curd. Under favorable conditions this may be omitted.

(210A) Cutting the curd may be begun by the use of the harp or by means of the wooden sword, or a lath sharpened on both edges and point. The curd is cut with the harp or sword in one direction, and again at right angles, forming columns of curd extending from the bottom of the kettle to the top.

Cutting is continued by use of the scoop, using the "turning over" motion (197B). This cuts off cubes from the top of the columns, and is continued until the entire quantity of curd at the bottom of the kettle has been brought to the top, and cut up into pieces the size of a walnut or larger. The "brake" is then put in place, and clamped to the kettle wall, usually at the maker's right.

(210B) The harp is then put in, or in a large kettle two harps may be used at the same time, or a single harp may be used, with the second man using a scoop to help set the curd in motion around the kettle. The harp does two things. It keeps the curd and whey in steady motion around the kettle, so that the curd does not settle, and it cuts the curd lumps finer. The circular motion is imparted to the whey with the outward harp stroke which follows the curve of the kettle wall half way round from the near to the far side at about the same rate that the whey ought to move. The return stroke is made by drawing the harp directly across the middle of the kettle, towards the operator, at a faster speed than the curd movement, thus cutting each large curd lump which the harp wires meet. The brake throws the curd from the side toward the center.

The speed of this harp movement must be carefully regulated, particularly at first, to avoid breaking up the soft curd into fine sandy particles, or curd dust, and thus causing loss.

The harping should be continued steadily, slower at first, and more rapidly later, for half an hour or until the curd is found to be firm enough so that it can be allowed to settle for an instant without danger of sticking together and forming lumps. As

time passes, and the curd becomes firmer, it may be allowed to settle longer, but if lumps are formed, they must be broken up by more violent stirring all of which should be avoided.

As the harping proceeds, the curd particles are cut finer, and they also undergo rapid shrinkage in size due to separation of whey from curd. When considered fine enough, about the size of wheat grains, the harp is taken out and replaced with the stirring tool, or breaker, which can be run by hand or by machine power. A thermometer is kept in the kettle, attached to the brake, to facilitate keeping the temperature up.

The stirring of the curd in this way may be continued for a longer or shorter period, and during this time, two things occur. The curd gives up whey and becomes firmer, which can be observed by taking up curd in the scoop from time to time, pressing it lightly in the hand, and rubbing up the lump before throwing it back into the kettle. No change in hydrogen-ion concentration is caused by rennet coagulation or whey separation. Biol. Jrnl. 1915, June, p. 215. Acidity may begin to develop, which can be observed by any increased acidimeter test, or other indicator, applied to the whey. In making Swiss cheese, the stirring, the final heating and the dipping are all usually carried to completion with only a little acidity increase above that observed right after cutting, which is usually .105 or .11%. The whole period from cutting to warming usually takes 45 to 60 minutes. A shorter time may be required with too ripe milk, or a much longer time if acid is lacking.

Some makers think it advisable to let the curd settle to the bottom, stopping the stirring for the last 10 or 15 minutes, and stirring the curd again vigorously to break up all lumps of curd just before beginning the heating. The object in mind is to help expel moisture and firm the curd. Others prefer to take no chance of forming lumps or leaving lumps in the curd, and continue the stirring without intermission. Whether the simple settling of curd is efficient in expelling whey, or whether any effect produced results from the finer breaking up of the curd afterwards by the final vigorous stirring is a question.

(211) When to Begin Heating. The most essential and difficult part of the work is to determine correctly just when to begin heating. As stated above, the extra moisture must be sufficiently expelled from the curd before heating begins. Too early heating dries the curd surfaces faster than the interior, forms a tough skin over the surface, and thus tends to lock in any extra moisture present. When this occurs, the test lump rubbed in the hands remains sticky, rolls up and does not rub apart into separate cubes.

As in making other kinds of hard cheese, a little acid development in the curd is required to properly expel moisture from the curd. It is necessary therefore with Swiss cheese to make sure that the first stages of acid development in curd have begun, to aid in expelling moisture, before the curd is heated up. Without an acidimeter, the maker must depend on his judgment of the feeling and firmness of the curd in the hand, which is hard for a beginner to learn. As soon as it is certain that the acid development has started, so as to expel extra moisture, the heating of the kettle may begin.

(211A) The Final Heating, or Burning. The final heating of the kettle checks the growth of some of the bacteria present in the curd, expels additional moisture from the curd, and to some extent stops rennet action.

The warming should usually require 20 to 35 minutes. Too rapid warming, like the use of a too high setting temperature, is likely to cause the formation of a tough skin over the surface of the curd cubes which retains whey inside, and is objectionable for other reasons.

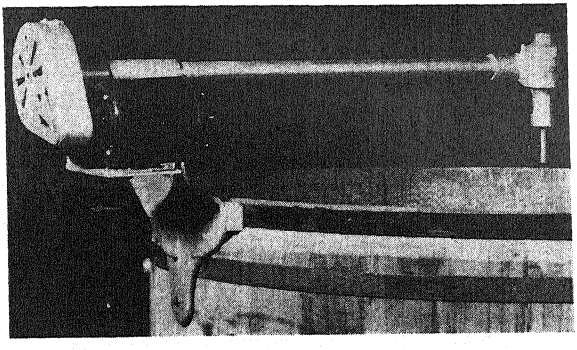
The final temperature influences the moisture content of the curd. Some factories heat usually to 43-47 R., (129-138 F.), while others rarely heat above 39, 40 or 42 R. (120-126 F.). The higher temperatures are used at factories having a warm curing room in summer, while factories having colder curing rooms heat the kettle to lower temperatures. A cheese heated to only 38 or 40 degrees is likely to soften, spread, and work too fast in a hot curing room, while a cheese heated high in the kettle is likely to require a warm curing room to make it open properly, since it is drier.

The final temperature and other details are regulated so as to cause the heated curd to be ready to dip in 25-50 minutes after the steam is turned off.

The stirring must be continued steadily during the heating, to prevent curd from becoming overheated on the bottom of the kettle, and to prevent curd particles from sticking together which they are especially likely to do, at about a temperature of 36 R. (113 F.) when the curd may soften somewhat and become a little sticky.

Some makers in summer heat the curd to a little higher final temperature, and then at once cool it a few degrees by pouring in a pail or can of cold water. This is intended to aid in avoiding a sour glass cheese.

(212) The Stirring Out. After heating, the stirring is continued steadily until the curd is found to be dry enough and



Carter 1942 Model Swiss Stirrer.

ready to dip, by making several tests. The test should be applied frequently, towards the last, as the curd changes rapidly, and may overstep the mark, if not watched closely.

(1) The test is usually made by catching some curd and whey in a scoop or dipper, settling, pouring off the whey, and pressing a handful of curd firmly in a uniform manner about six times, turning it over each time. The lump of curd is then tested by bending it at a right angle over the finger to see whether the curd breaks easily, or sticks together and bends (153A).

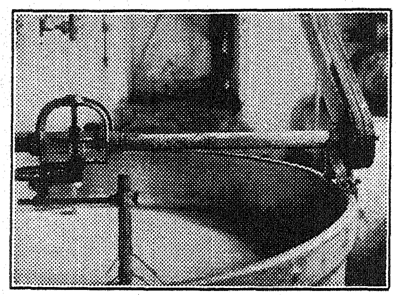
The longer the curd is "stirred out" in the kettle, the drier and firmer the curd cubes become, and the less easily they will stick together in the hand, when given the test. When the curd has finally reached the proper condition, the test piece in the hand will break off short when bent over the finger. This condition increases as time passes, and a curd which is left too long in the whey, after it gives this test will become so short and crumbly that it can hardly be made to stick together at all, even in the cheese press after dipping, but the rind will crumble easily, and peel off when the cloth is removed, also the cheese may break in two when being turned over, and should be turned very carefully and somewhat later than a normal curd.

(2) Also the same lump of curd when rubbed between the palms will fall apart into its separate cubes. If it remains sticky and rolls up, it was not properly dry before beginning to heat the kettle (211).

The aim of the maker is to use the hand test as means of judging when to dip the curd so that it will go into the hoop with just the right consistency, so that the cubes will remain separate on the press for a short time, to permit proper draining and then close up promptly into a solid, compact cheese which will not crumble apart or peel the rind. A curd which re-

quires about 30 minutes stirring out, should be in the hoop within five minutes after it has given a good test in the kettle, in order not to become too short.

Generally speaking, when a curd requires less than 25 minutes or more than 50 minutes stirring out, something was wrong in the milk or the work. With too ripe milk, too high a burning temperature, too much starter, etc., the time may be shorter than



Stirring Equipment for Swiss Cheese Kettle.

25 minutes. Too low a burning temperature, lack of starter or acid in the milk may cause the stirring out to be too long continued. Also, if a curd is not stirred enough so as to become properly dry and firm before the final burning, it may take a long time for the final heating and stirring to get the curd properly firm. Generally too long stirring out means too early burning.

If a curd heated to 41 R., is not ready to dip in 45 minutes it should have been stirred longer before burning, or else more starter should have been used. If a curd at 41 is ready to dip much earlier than in 20 minutes, the milk was too ripe, and a good cheese usually will not be obtained.

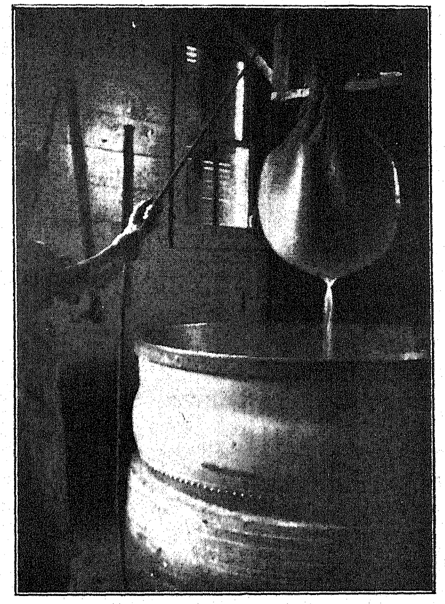
(212A) The Time Periods in Making. An estimate of average time periods may be as follows. From adding rennet to first cutting, 20-30 minutes; First cutting to first heating, 45-60 minutes; Heating, 20-35 minutes; Stirring after heating, 25-45 minutes; Total 1 hour 50 minutes to 2 hours 50 minutes.

(213) Dipping the Curd. The temperature of the kettle at dipping should be about 40-42 R. (122-127 F.) in most cases, as this influences the fermentation in the cheese on the press.

Just before dipping, the curd is given a final rapid stirring by hand with the breaker, which is then held firmly in an upright position, the object being to settle the curd quickly in

the middle of the kettle, to facilitate dipping, and also to secure an even distribution of the large and small curd particles and the curd dust, if any, throughout the cheese. Too hard stirring at this point is likely to throw the larger pieces, if any, into a circular position round the outside of the cheese, and later cause rind-holes.

After the curd has settled for a short period to stick together somewhat, the cheese cloth is slipped under the curd, with the aid of the steel strip, or boegli, without disarranging the pile of curd, or tipping it over. The four corners of the curd cloth are tied together the hook is adjusted, and the bag of curd hoisted with the block and tackle, wheeled over the press table along



Swiss Cheese Dipping. The cloth bag of curd hoisted from the kettle is drained for a few seconds as shown, before transferring to the press table and hoop.

the overhead track and lowered into the hoop. The curd drains rapidly at first while over the kettle, and while being moved to the press; the bag of curd in the hoop is held tightly, close above the curd, as it goes into the hoop to prevent splitting the curd at the top. With the flat hands, the top of the curd pile is pressed somewhat all around to expel loose whey and prevent accumulation of whey in holes, leaving the pile of curd higher at the middle, so as to facilitate draining of whey and avoid whey pockets. The cloth corners are drawn tightly across the cheese,

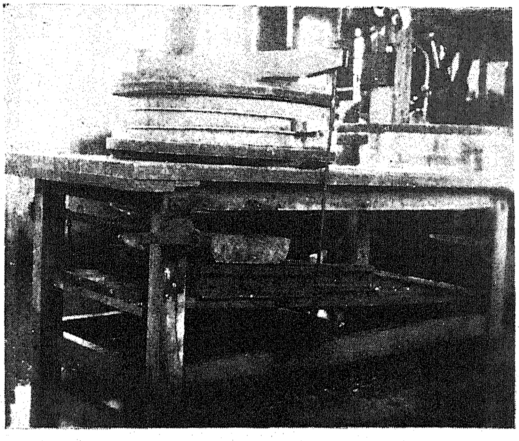
tucked into the hoop, if they will reach, and the upper press board is put on. The size of the hoop must be adjusted, during this process, so that the height of the cheese will be great enough to keep either press board from touching the hoop by a quarter of an inch, so that the cheese bears the pressure. A light pressure is applied by putting on a weight, a pail of water, or a keg of bricks, the object of this pressure being simply to give the cheese the proper shape in the hoop. Too much pressure at this point will close up the rind, prevent free draining, and perhaps cause the curd cloth to stick to the rind, so as to tear the rind when changing the cloth.

A second dip from the kettle, with another cloth, may bring up a small additional lump of curd, called a strebel, consisting largely of curd dust. If very small or bluish in color, it is thrown away. It is pressed in to one side of the cheese, next the hoop. The strebel seldom develops normal eyes, but is generally "nissler," or full of small gas holes, after curing.

The acidity of the whey drips should be tested after the cheese has been turned, and should slowly increase, until five hours after dipping, the drips test at least .65% acid. If only .25-.45%, this indicates that the cheese is somewhat lacking in acid, more starter should have been used, and the cheese is liable to be gassy, or nissler. Acidity is desirable, as well as many other factors to produce a fine cheese.

(213A) The pH Test on Curd. According to Rogers, Hardell and Feutz (Jour. Dairy Sci. 22 (1939) No. 1, pp. 43-48), when the culturing and manufacturing processes were so adjusted as to give a pH test between 6.35 and 6.51 at dipping time, a high percentage of the cheeses could be expected to grade A or B, while a pH of over 6.51 greatly reduced the chance of producing high grading cheese. When the pH at dipping fell below 6.3, it was generally attributable to active thermophilic coccus organisms which developed even during cooking time, and the defective cheese could be attributed directly to abnormally high acidity. (40)

(214) The Cheese on the Press. The cheese is turned usually about 5-10 minutes after dipping. For this purpose, the hoop is removed, the cloth pulled down to the table, and a fresh cloth is spread quickly over the cheese, and the hoop replaced before the cheese has had time to spread. The cheese in the hoop between the press boards is quickly turned over on to the other press board, the first cloth is taken off, and at this time, the upper surface of the curd, when rubbed, should show a certain sandy condition, and should split slightly under pressure of the hand, indicating that the curd particles are sticking together but not



Modern Movable Cheese Press.

too rapidly. The cloth corners are now pulled up to remove all wrinkles, and spread evenly over the top of the cheese to avoid forming creases which might afterward cause splits. The press board is put on, and the weight applied, as before. Frequently a square of heavy burlap is applied to the cheese outside the curd cloth, at the first and additional turnings, to prevent the curd cloth from being pressed too much into the cheese rind so as to cause tearing when removed, and also to aid in draining the bottom of the cheese.

The press drippings should be clear and not too milky, as the latter condition indicates faulty milk or workmanship, and probably splits or whey pockets in the finished cheese. Quick work in turning cheese is necessary and other precautions should be taken to avoid too rapid cooling of the cheese. Heavy pressure is sometimes applied after the first turning, finally up to 20 times the weight of the cheese. The modern tendency with well made cheese is toward lighter pressure.

The cheese should be turned 2 or 3 times during the first two hours and later at longer periods, increasing the pressure somewhat each time. Too long a time on one side is likely to cause accumulation of whey in the lower side of the cheese, and prevent normal eye formation on this side. If the cloth sticks to the curd and does not pull off easily, scraping the outer cloth surface with a spoon, will remove the curd pressed through the meshes, and facilitate removal of the cloth. A short texture due to too late dipping, or too high heating, will cause the curd surface to tear easily, and the pressure should be light, and the first turning delayed a little to allow the curd particles to close up better. A circle of cheese cloth gauze may be applied on the

ends or a strip around the edge, at the second or third turning, inside the press cloths, and left sticking to the cheese. The cloth does not improve the quality of the cheese, but prevents peeling and cracking.

A well made cheese, after 15 or 16 turnings (European practice), 7 or 8 hours after dipping, should be quite dry on the rind, and hardly wet the boards as the cloth will retain all the drippings. Many makers turn a cheese only about five times during the day, and again in the morning. Whey spots, if detected by the sound, when striking the cheese surface with a spoon or the finger, should be stuck with a needle and either cut out, or drained with a pipette or sucked or pressed dry.

After about 10 hours pressing, the cloths are laid flat on the press board so that the cheese edge surface is pressed smooth for a time against the hoop, which greatly improves the appearance of the edge and facilitates cleaning the cheese in the curing room. At the last pressing for an hour the heaviest weight should be used, and the finest thread of cloth, or all cloths may be left off to smooth the flat sides of the cheese. The corners of the cheese, pressed out between the hoop and the board while pressing, are cut off at each turning, as they are likely to cause splits at the edge, called "frog mouth."

The normal pressing time is about 20 hours. The cheese are yet somewhat warm, and in order to avoid warming up the brine tank, the cheese are often salted for one day with dry salt, to permit further cooling, and to harden the edge before finally removing from the hoop.

Too rapid cooling during pressing is indicated when large eyes appear near the center, and the cheese is nissler near the surface.

When the edges are cut after the last pressing, the cut surface should be closed and show no moisture drops. The cheese surface should be yellowish with whitish blotches, and dry. Before going into the salt, the cheese is labeled with wet soot, or a stencil, or with an indelible pencil in a wet spot, indicating the month, day, P. M. or A. M., and the kettle, if several are used. The records should show what milk was used, and how handled in the kettle.

(215) Swiss Cheese Curing Process. Various theories as to how eyes are formed in Swiss cheese have been advanced. One of these, widely accepted, is as follows. The lactic acid bacteria in the cheese convert the milk sugar in the cheese into lactic acid. (In a few days after the cheese is made, the milk sugar in it has entirely disappeared.) The casein of the cheese begins to lose its curdy quality and begins to become more waxy

and elastic. The lactic acid combines with lime salts in the curd forming some calcium lactate. In the warm room, another class of bacteria present in milk, the propionic acid group, work on the lactate of lime, and form some propionic acid and some carbon dioxide gas. The carbon dioxide gas begins to collect in the form of small bubbles, or the beginning of eyes. As more gas is formed, the gas pressure in the holes enlarges them. If the cheese has a good elastic texture during this time, the holes remain round and increase in size. It is important that the eyes be formed in the early part of the curing, because the curd becomes shorter after a time, and if the eye formation is delayed until the curd is short, the curd will split sidewise, under the gas pressure, and the cheese will show glass, instead of round eyes. B. A. I. Bul. 151.

From this it will be seen that the milk and the cheese must contain sufficient lactic acid bacteria, and as the ordinary sour milk bacteria are mostly killed by the high temperature of the kettle, it is necessary to have a particular kind of lactic germs present, which are able to grow well at a high temperature, and are not killed by the kettle heat. These are usually present in sour and in "lab," but a pure culture starter is less likely to contain other harmful germs, which might injure the cheese.

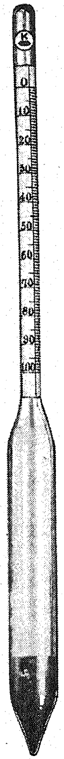
It is important that the cheese on the press be kept warm, and prevented from cooling too fast, in order that the acid germs may work freely. Afterward, the cheese is cooled and salt is added to prevent the fermentation which produces eyes from going on too rapidly and causing a bloated cheese. The best temperature for the first eye formation usually is about 14.5-17.5 R. (65-71F.)

(215A) Experimental Swiss Cheese From Pasteurized Milk. In Research Bulletin 264, (Iowa), Babel and Hammer describe the addition of various starters to pasteurized milk Swiss cheese, discuss factors affecting the ripening of Swiss cheese, and list other bulletins on this subject. Few if any Swiss factories are now pasteurizing milk for Swiss cheese.

(216) Cheese in the Salting Room. From the press the cheese is taken into a cold cellar at about 50-54 F., where it may be salted in the hoop, or in the prine, or partly in each. for 6 days ?

The older method of salting in the hoop is done by taking off the hoop, wiping the inside of it with a cloth wet with brine, and sprinkling dry fine salt on the wet surface. The hoop is put on carefully, and the top side of the cheese is washed well, placed level, sprinkled with dry salt and wet with water. The salt slowly dissolves and the brine is absorbed gradually. This is repeated daily, turning the cheese over each time, and may be

SODIUM CHLORIDE (SALT) BRINE TABLE.



Salometer Reading at 60° F.	Percentage of Salt by Weight	Specific Gravity at 60° F.	Salt Required	
			Lbs. Per Gallon	Lbs. Per Cu. Ft.
4	1	1.007	0.084	0.63
8	2	1.015	0.169	1.26
10	2.5	1.019	0.212	1.58
12	3	1.023	0.256	1.92
14	3.5	1.026	0.300	2.24
16	4	1.030	0.344	2.57
20	5	1.037	0.433	3.24
24	6	1.045	0.523	3.92
28	7	1.053	0.617	4.63
32	8	1.061	0.708	5.3
36	9	1.068	0.802	6.0
40	10	1.076	0.897	6.7
48	12	1.091	1.092	8.2
60	15	1.115	1.389	10.4
80	20	1.155	1.928	14.4
96	24	1.187	2.376	17.78
100	25	1.196	2.488	18.68

continued four to six days, according to the size of the cheese, the temperature, etc. Salt penetrates curd slowly, in 15 minutes about .05 inch, and 1¼ hours about .15 inch, and .3 inch within 1 day. N. Z. Dairy Research Institute, Publication No. 74; Jrnl. Dairy Research 1936, 171.

Salting in the brine is usually begun after the young cheese has been salted one or two days in the hoop, and fully cooled. The salt brine should not be above 60, nor below 46 degrees F. In making the brine, 20 to 22 lbs. of salt are used to each hundred pounds of brine. The brine should be about 80-90% saturated with salt, containing 20 to 23% of salt. A small graduated float, called a Salometer, can be purchased for testing the strength of brine. The maker also observes that in good brine, the cheese floats about ½ inch above the surface of the liquid. Cheese should not be put more than two deep in the brine, and should be turned over daily, and as the cheese takes up salt from the brine, some dry salt is sprinkled over the surface of each cheese daily after turning in the brine.

(217) In the Cool Room After Salting. After 2 or 3 days in the salt brine, the cheese is placed on dry circular boards, called "lids" and kept in the cool room at 40 to 45, or 50 to 60

F., for 10 to 14 days, turning it over on to a clean dry board every day or every other day, and washing the surface with salt brine, but putting on no dry salt.

(218) Cheese in the Warm Room. The cheese in the cool room gains a certain elasticity, which can be observed by pressing the surface with the hand, which shows that it is ready for the warm room, usually after about 2 weeks in the cool room. It should be placed first in the coolest part of the warm room, near the floor, at about 65 F., and gradually moved toward the warmer parts, watching the sound and appearance of the cheese as indication of eye formation. If cheese are placed at once in a warm place, they will also soon be covered with fat coming through the surface, which tends to prevent the absorption of salt, unless the cheese are thoroughly scraped. The cheese surface forms a good deal of dry coating or scab, which must be carefully removed after turning the cheese every other day, by washing with water, then rubbing with a cloth and fine salt, and finally sifting more or less fine salt over the surface. The dry lower side of the cheese rests on a dry board or "lid." A wet board is apt to cause a soft rind spot.

The humidity should be kept high, about 80-85%, and the temperature 68-77 F., (see 211) or higher if required. The temperature in cheese cellars in the country is apt to go higher in summer, as artificial refrigeration is seldom provided except in the largest factories.

A bare earth floor tends to keep the air moist, but is insanitary, and should always be covered with concrete and provided with a floor drain if possible. A large kettle of water over the stove gives off a little moisture continually, and is used in many factories. Wet saw dust on the cement floor is sometimes used, or a spray thrown on the floor each day, or a steam pipe from the boiler is opened for a time daily. If the curing room has steam or hot water radiator heat, wet cloths thrown over the radiators will provide moisture.

Too much dampness will make the cheese moldy and the rind will not dry properly. Dry sawdust on the floor, or a little ventilation by opening the windows will dry the air somewhat, but admitting outside air will also change the temperature.

Too dry a curing room, or direct currents of air on the cheese will dry the rind so that it is likely to crack, and should always be avoided.

Turning cheese must be done quickly and skillfully to avoid breaking the edges of the cheese.

In the warm room, cheese is salted very lightly, until it has begun to open well, when more salt is used to prevent excessive

fermentation. About four hours or more after the cheese is turned and salted, in a properly moist curing room, the salt will have dissolved, forming large amounts of brine on the cheese surface. At this time, the cheese should be rubbed with a large flat brush to distribute the brine evenly over the surface. By next day, or the second day, the salt brine will have gone into the cheese, leaving the surface dry. The cheese is then turned over on a dry board, washed, rubbed with salt, sprinkled with dry salt, etc., repeatedly using the amount of salt, the temperature, humidity, and the washing as means to regulate and control the eye formation, so far as possible. The edge or hoop-side of the cheese is rubbed each time with a cloth wet with the brine, and the whole surface should be kept as clean and bright as possible. Experience is necessary to learn these and other details.

(219) Final Curing. After the cheese is properly opened, as shown by testing with a small trier, by the sound and feeling of the surface, and by the shape of the cheese, it is carried to a moist, cool cellar, at 60, F., turned, washed and salted about twice a week, rubbed well and thoroughly dried before turning again. (It may then remain at 35-40, F., until 4, 10 or 12 months old, according to market demands, and should improve in flavor steadily.)

Temperatures used in the curing cellars may be as follows, according to reported European practice.

	Temperature	Humidity
For fresh cheese	52—59 degrees F.	90—95%
For the first curing room	60—65	85—90%
For the warm curing room	65—70	80—85%
For the storage room	50—55	80—85%

Warm rooms are sometimes heated to 90 F., in Wisconsin, and to 70-75 F., in Ohio.

(220) Faults in Swiss Cheese. As No. 2 quality Swiss cheese sells for only about half the price of No. 1 cheese, the factory income depends on how large a proportion of No. 1 or fancy cheese can be obtained. Cooling milk promptly on the farm, and clarification will often prevent trouble. The common faults in Swiss cheese are easily recognized.

(a) Pressler cheese develop too many eyes, too early in the process, often have a poor flavor, and are so called because they open on the press. This is caused by the presence of too many gas-forming bacteria, usually derived from manure or unwashed utensils, or from lack of starter and acid forming bacteria which if present might check gas formation. Cows with injured udders, inflamed and containing pus, or the accidental dropping of silage or any fermented yeasty material into the milk pail or kettle may be the cause.

Night milk in summer held on the farm, and not thoroughly and quickly cooled may cause this trouble. Gassy lab or sour, or other sources of contamination, or faulty manufacture leaving too much moisture in the cheese, or too warm curing rooms, may be the cause of these and other faults in cheese. Cleaning up the milk supply or steaming the whey or use of extract instead of lab may correct the trouble.

(b) A cheese which does not become gassy on the press may do so in the salting brine, due to the same causes, as listed above. The flavor may be good or sometimes bad. Using a good starter and keeping the cheese as warm as possible on the press to promote acidity may avoid the trouble.

(c) Cheese may form fairly good sized eyes, and yet not round and smooth, as they should be, but irregular in shape, sometimes compared to the inside of a walnut shell. Observations of the Swiss Dairy school, in Switzerland, indicate that this results from the use of too ripe lab, or over 1.40% acidity. due to too long ripening, which should not be over 30 hours. Oversetting is often corrected by clarification.

Cheese with a large proportion of fat also show irregular eyes, in small groups, called fatnests, which can be avoided by standardizing the milk (205).

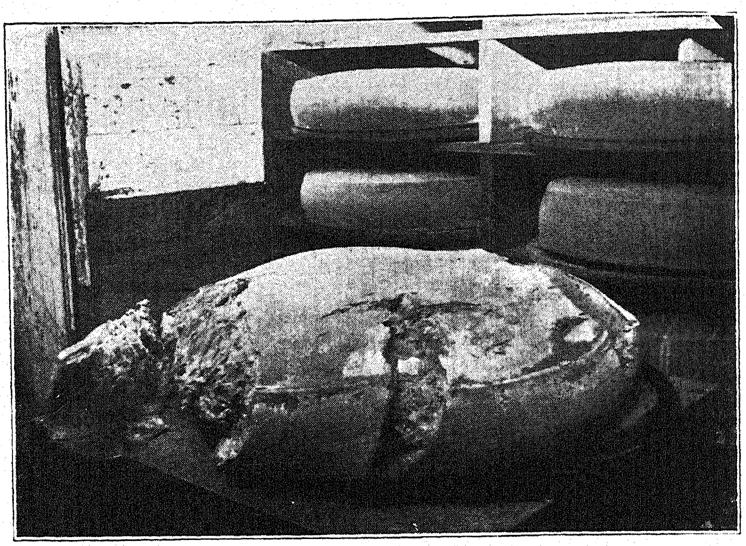
(d) Late fermentation is said to occur in Switzerland as a result of using sweet-press-silage made from grass and various plants. The sour corn silage used in America does not appear to be as harmful as the sweet silage, and is used by farmers at a great many factories producing good cheese. Trouble which may be due to many different causes is often attributed to silage, but it is certainly true that corn silage must be properly made and handled to avoid trouble.

The sweet silage contains many butyric acid germs. which are liable to cause very bad bloating of cheese, with hydrogen gas.

The sour silage contains mostly lactic acid germs, but also yeasts. It is therefore necessary to avoid getting the hands smeared with silage in feeding cows before milking, and to keep silage particles out of the milk. As yeast once introduced grows freely in the whey tank, the steaming of the whey has been found most helpful in many cases in stopping trouble from this source.

A gassy foaming sour is likely also to cause cheese to bloat 8 to 14 days after manufacture. If the sour has a good flavor, the foaming can often be stopped by heating it to 135 F.

(220E) Bloated Cheese. By washing bread pans and milk cans with the same water, at the farm, the cans became infected



Bloated Cheese caused by Foul Whey Tank.

with yeast. The yeasty milk produced Swiss cheese that bloated and cracked open within a week. In the factory whey tank, the yeast grew rapidly, infecting every can of whey taken to the farms. Each day, one or another farmer failed to wash the cans well, resulting in yeasty milk and bloated cheese. This occurred every week during more than six months, causing serious loss. The bloated cheese were unsalable and were buried or fed to pigs.

The trouble was stopped entirely by steaming the whey in the whey tank every day, immediately after separating the whey.

(F) **Stinker cheese** have caused much trouble and loss in past years at certain factories. The cause is not fully understood, but undoubtedly greater cleanliness and better starters are required. Wis. bul. 373, p. 72 (202B).

(G) **Glass Cheese.** Too much acid in cheese makes the texture short, so that the eyes once formed, fail to enlarge in round shape, but split out sideways, producing a No. 2 cheese.

Late fermentations may also proceed so rapidly as to split sideways the eyes that were forming normally and slowly enlarging before the late fermentation started.

Glass cheese often results from "choked" milk, that is, milk which was not properly cooled. The resulting warm milk favors the growth of bacteria, and may make the kettle too acid.

Blind glass cheese have no eyes at all, which is often observed where milk is overripe, or the cheese too acid for any cause.

(H) **One-sided Cheese.** Faults in one side of the cheese which is otherwise of good quality indicate uneven composition of the cheese. Lumps of wet, uncooked curd inserted in normal cheese at the Wisconsin Dairy School frequently produced nissler spots in an otherwise good cheese. Insufficient dilution of sour or starter with water, or lack of stirring in, may cause lumps of curdled milk to be formed, containing no rennet and too much moisture and resulting in faulty spots where these lumps occur in the cheese.

On the press some cheese drain well, and need less turning. Others drain poorly and if not turned often enough, may develop eyes on one side but glass on the other, where the moisture is high.

(I) **Split Cheese.** The cause of "frog mouth" has already been indicated (214). Marks on the cheese surface due to folds on the cloth or loose threads, may later be the places where splits occur. Moist spots may cause bloating and splitting, and the openings often become infected and foul in odor, and are called stinkers. (220E).

Cheese often split on the surface in various irregular lines, due to high acidity, dryness, and shrinkage of the surface, which may also result from a too dry curing room, or air currents from a window, or a fan, if used.

(J) Red or pink spots in young Swiss cheese, becoming brown with age, are due to propionic acid forming bacteria. They are very abundant in manure. The milk should be kept cleaner. Their growth is favored by low acidity in curd and cheese. When insufficient acid is produced on the press, propionic acid fermentation starts early, producing too many and too small eyes, and the red or brown pigment.

(221) Cheese Composition and Yield and Score Card. The average composition of Swiss cheese is given by European analysts as follows:

Water	33.18%
Fat	31.44
Casein, etc.	27.84
Salt	2.30
Ash, etc., other than salt	2.92
Difference	2.32
Total	100.00%

The fat-free dry matter is thus about 34-35%, and the per cent of fat in dry matter as an average figure for 641 cheese was

48.69%. Only 9 of these cheese contained 42.5% or less fat in the dry matter. See also (70).

The yield of cheese from milk containing 3.4% fat and 12.45% total solids averages 9.4 pounds per hundred of milk, after pressing and 8.53 pounds when ripe for sale.

Score cards for Swiss cheese which have been used in Europe and America are as follows:

	European 1895	1915
Appearance	5 points	4
Fine texture	5	5
Odor and taste	5	5
Eyes	10	6
Total	25	20

American Score Card for Swiss Cheese, Now in Use

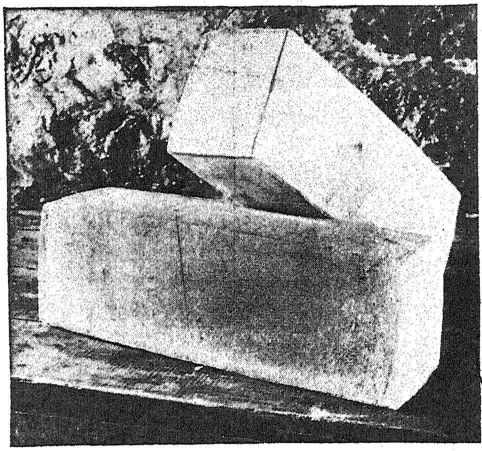
Flavor	35
Holes	30
Salt	10
Texture	20
Style	5
Total	100

(221A) Moisture Content, Quality and Yield. In a study by Sanders, Farrar, Hardell, Feutz, and Burkey, (Jrnl. Dairy Sci. Sept., 1940, vol. 23, 905-918, correlations of analytical data with grades of 218 experimental and 418 factory Swiss cheeses indicated that the presence of an excessive amount of moisture is generally detrimental to the quality of the cheese.

Laboratory results on yields of cheese per hundred pounds of milk indicated that some of the manufacturing variations which may be used to bring about the inclusion of excess moisture actually result in decreases of yield, and that in general the inclusion of a comparatively large amount of moisture does not result in sufficient increase in yield to justify the practice. A study is presented showing effects of numerous variables in the milk and making process upon the moisture content of the cheese.

(222) Block Swiss Cheese. Where the quality of milk does not permit making the best quality of Swiss, or the factory is not provided with suitable curing rooms, or in the early and late ends of the season when the milk supply is small, the bag of curd may be dipped from the kettle into an oblong wooden frame or mold, 20 inches in width, and adjustable as to length, by means of blocks and sometimes a screw set in one end. The oblong block of cheese is pressed for half a day, and then cut with a knife

cross ways into strips about six inches wide, which are each wrapped in a cloth, placed in individual molds and pressed farther to put a closed rind on the cut surfaces. Block cheese are salted as usual, but frequently no attempt is made to develop eyes in them. They may develop good flavor, but sell for a lower price than No. 1 round Swiss cheese.



Block Swiss Cheese.

(223) Swiss Cheese Maker Books. Among the books read by Swiss cheese makers in America, and written in the German language, is the Praktische Anleitung zur Fabrikation und Behandlung des Emmelthalerkaeses, written by Professor A. Peter, late Director of the Swiss Dairy School at Rutti-Zollikofen, Switzerland, to whom the writer gratefully acknowledges obligation, for frequent assistance by correspondence, personal interviews, and through publications.

The European methods there described differ in some important details from the methods used in America, described in this book.

(224) X-Ray View of Swiss Cheese. Recently, Swiss cheese buyers and sellers have become interested in the possibility of inspecting the quality and value of every cheese, quickly and without drawing trier plugs, by revolving each cheese before an x-ray machine, and thus viewing or photographing the size and distribution of the "eyes" inside the cheese, on which its market value depends.

By this means, no portion of the cheese could be overlooked by the inspector, while all damages from the present-day repeated plugging would be avoided.

CHAPTER XXVII.

American Cheese for Three Markets

(228) The Quality Should Suit the Trade. In North America, enormous quantities of whole milk cheddar cheese are made for three markets. Canadian cheese made throughout Ontario and Quebec are sold mainly for export to Great Britain, or to residents of Canada, and nearly all of this cheese is made firm, close, slow curing, and containing about 34 to 36 per cent of moisture.

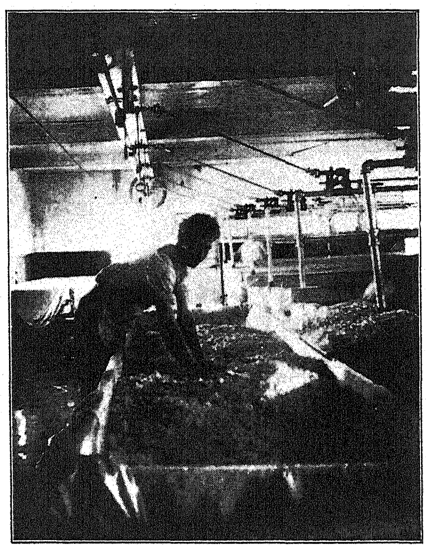
In the United States more or less has been made for export, yet the greater part is intended for sale throughout the western and southern states. The quality for this purpose need not be quite so firm, close, dry, or slow curing as for export, and the moisture content is about 36 to 39 per cent in Wisconsin, the upper limit being established by state law at 39% with 1% tolerance, or higher if so labeled, and at 39 per cent by federal laws controlling interstate commerce.

In some other states, having as yet no cheese moisture laws, cheese made in local factories are sold and eaten almost entirely within the state, and for this purpose the standards of quality are often much lower, the cheese being frequently quite open or full of holes, quick curing, soft, and containing 39 to 43 per cent of moisture. Such cheese are entirely unsuitable for either the export trade or the great southern trade, and are fit neither for shipment to any distance nor for storage through the winter, as in either case they are likely to deteriorate greatly. These are sometimes called "northern trade," or "home trade" cheese, etc.

These three classes of cheese differ so greatly in their quality and method of manufacture, that it is necessary for a maker to decide definitely which kind of cheese his trade demands, and what market he is intending to supply, before beginning work.

(229) Method of Making Canadian Export Cheese. The milk in the vat is commonly treated with about 1% of starter, and is set at 86 degrees, at about .175% acidity by the acidimeter, using 3 or 3½ ounces of rennet extract per thousand pounds. The curd is cut in about 40 minutes when showing clear whey in the break, but while yet rather softer than is customary in Wisconsin, using ⅜ inch horizontal wire knives and ¼ inch vertical wire knives, and lapping the vertical cuts so as to almost double the cutting effect upon the fineness of the curd cubes.

The agitators are started slowly, immediately after cutting, and the steam is turned on slowly, so that the vat is heated to about 100 degrees in about 45 minutes. After heating, the whey is



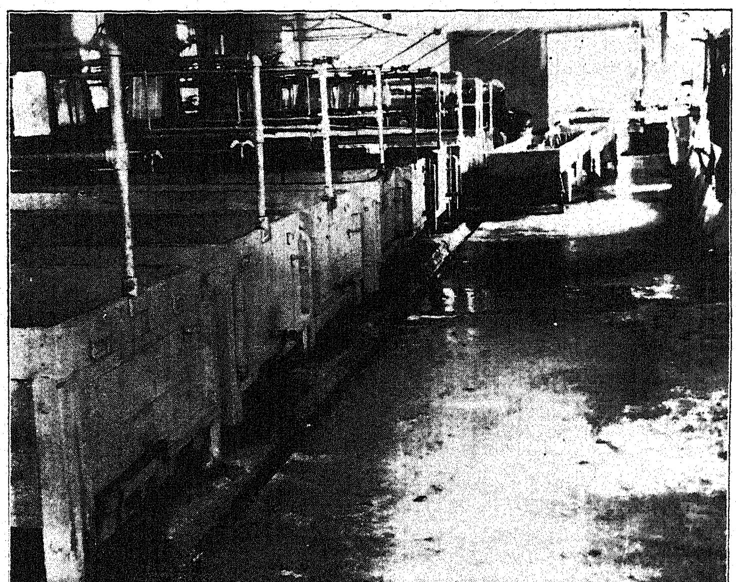
Curd Sink in Use in a Large Canadian Factory.

drawn down about 8 inches in the vat, and the agitators are run faster, at about 12 revolutions per minute.

The whey is tested for acidity with the acidimeter at intervals, and the curd is allowed to become quite firm and elastic, so as to spring apart well, much more so than at many factories in Wisconsin. The whey is drawn 2½ to 3 hours after setting the vat, at a whey acidity of about .17%. Three hours time is preferred rather than 2¼ hours. As much whey as possible is drawn out through a strainer and siphon, as the vats often have no gates attached to the pans. The remaining whey together with the curd is then dipped out of the vat by two men with flat sided curd pails, into a curd sink with a slat bottom, covered with a cotton cloth. In the sink, the curd is stirred by two men, during a full half hour, so as to keep the cubes from matting, and to allow complete drainage of whey from the curd. In this way, all danger of soft, whey soaked cheese, containing excessive moisture, is avoided. Sometimes with milk riper, the whey is drawn at acidity as high as .20%, but preferably as described above. When the make room is cold, the curd sink is run into a warm press room.

The curd is allowed to mat in a pile about 8 inches deep, and ½ an hour later the matted curd is cut across into long strips, which are turned over on the cut surface in the curd sink. In half an hour more the strips are piled two deep, and repiled at regular intervals to keep the temperature even, etc. About 2 hours after matting, the curd is milled. One hour later it is salted, and ½ an hour later, it is packed firmly into the hoops by use of a wooden club. This makes a total of 6 to 7 hours from setting to hooping.

The curd is so firm and free from excessive moisture that just before salting, to obtain 10 c.c. of curd drippings with which



Canadian Cheese Factory with Ten Vats in Use.

to make an acid test, it may be necessary to wring the corner of the curd cloth in the hand. The acidity may be 1%.

The cheese thus made are either held at the factory or shipped without delay to the buyers warehouses, and cured by the cool curing system at about 60 degrees, and the product thus made is surprisingly uniform in flavor, texture, body, and keeping quality.

The method described above was observed by the writer in 1914, 1915, and at intervals in later years, at a number of the largest factories in Ontario, some of which had 8 or 10 large vats full of milk daily and also in Quebec.

Under the close supervision of government inspectors, in Ontario and Quebec, a high degree of excellence and uniformity is attained both in factory construction and maintenance, and in quality of cheese produced.

(230) Methods of Making American Cheese in Wisconsin. In making cheese in Wisconsin for the southern market, the method is of course the same in a general way but with some important differences as to details.

There is perhaps more variation in method among factories in Wisconsin than among those observed in Canada. The milk acidity when received is from .16 to .20, and if of .18% or less is set with about 1% of starter and 3 to 4½ ounces of rennet extract. The curd is cut in 25 to 45 minutes, when fairly firm and showing clear whey when broken with the finger.

Stirring is begun with the arms, or agitator, immediately after cutting and is continued with little or no stop until the curd has been heated up to the desired temperature. The heating is begun about 15 or 20 minutes after cutting (or sooner with overripe milk), and the temperature is raised slowly and steadily up to about 100 or 102 degrees, or sometimes a little higher, stirring while heating.

With a "normally working" vat of milk, the acidity of the whey increases to about .17% in about two hours after the rennet is added and the whey is drawn at about this acidity. A great many makers incline to a lower acidity of milk and of whey and a few prefer to develop acidity higher than the figures given above so that the curd shows about 1/16 or ¼ of an inch of fine strings by the hot iron test, and the whey tests .20% just before it is drawn.

The vats in Wisconsin have gates, and the whey is allowed to drain out completely, the curd being retained in the vat by a tall, round strainer, having a tip which fits into the vat outlet, just above the gate. No curd sink is used in Wisconsin factories.

It is planned to have the curd as firm as desired, at the same time that it shows the required acid test, and in this case no stirring of the curd is necessary after drawing the whey, but a gutter is made with the hands or a rake down the middle of the curd, piled about 3 to 6 inches thick and covering all or part of the bottom of the vat evenly. The gutter permits the last whey to escape freely, and the curd is allowed to mat, on the bottom of the vat, into a solid mass. In about five minutes, when well matted on the bottom, so that the escape of whey is slowed up, the curd is cut across the vat into blocks about 1 foot wide, and the blocks are immediately turned over. The curd is turned again after 20 minutes, when well matted on the bottom, and

is piled two or more blocks deep and repiled at 10 minute intervals to keep the curd at uniform temperature throughout.

The curd is milled, preferably when it will string ½ inch or more on the hot iron, or test about .5% on the acidimeter, and is well matted so as not to fall into cubes when milled. In many cases, an hour and a half after matting will find the curd in good condition to mill. Some makers will mill a curd much earlier, when it is matted only half an hour but before it has much acid, in their effort to retain moisture and gain yield.

After milling, the curd is left at least half an hour, and if it appears very greasy, may be rinsed with water at 90 degrees to remove the grease. It is salted with about 2½ pounds of salt per 1,000 pounds milk, or per hundred pounds of curd, and is left in the vat at least 30 minutes with frequent stirring until the salt is fully dissolved, and the curd is once more smooth and velvety. It is packed in the hoops at about 80-85 degrees temperature and pressed over night. It is placed in the curing room shelves and turned daily for a few days to dry the surface and is boxed and shipped when 3 to 8 days old. Shipping or paraffining in less than 3 days was prohibited by the Wisconsin Dept. of Agriculture.

(230A) Method of Making "Soft" American Cheese for Northern Home Trade. In this process, the purpose is to finish the work at the vat as soon as possible, to retain a larger proportion of moisture in the cheese and thus to increase the yield, and hasten the curing of the cheese.

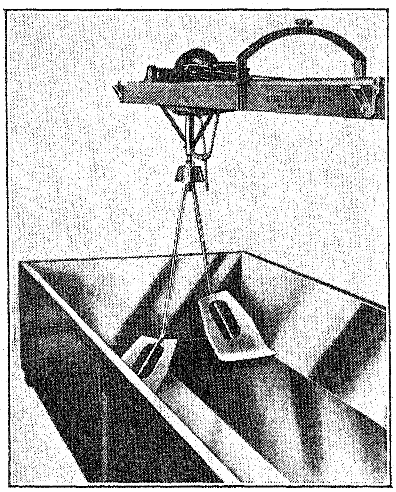
The general method employed to retain moisture is (1) to use sweet milk, ripened little or not at all, and little or no starter, and (2) to shorten the time for all parts of the work.

CHAPTER XXVIII.

Other Sorts of American Cheese

(231) Granular Curds. The granular or hand-stirred process of making American cheese was widely used in the early days of the American cheese industry. It is yet used occasionally when a maker wishes to finish his work earlier than usual for any reason, and by a few makers who make "Colby" cheese.

In the granular process the curd is made a little firmer by (1) holding it longer and perhaps developing a little more acid



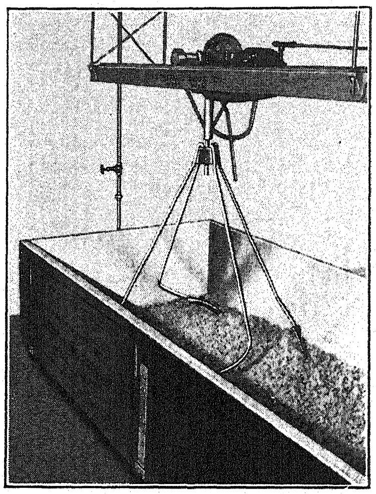
Modern Milk and Whey Stirrer.
Replacing the paddles with forks, the same outfit is used as a forker of curd.

before drawing the whey; and (2) after drawing the whey, the curd is stirred steadily to keep it from matting, while spreading it out to cool on the vat bottom. The mechanical curd forker does the stirring easily.

After stirring vigorously for about 20 to 30 minutes, the curd has become firmer and cooler and has little tendency to mat. It is now mixed with salt at the usual rate and as soon as the salt has dissolved, the curd is filled into the hoops and pressed.

The granular made American cheese can be distinguished in the market as the interior shows distinctly the separate cubes in the small openings in the cheese.

The matting or "cheddar" process which has largely displaced the granular process has advantages (1) in allowing the curd to be held longer in the vat before pressing, to develop more acid, and to work out any gas or pinholes, thus greatly reducing the danger of cheese becoming gassy on the shelf,



Modern Curd Forker.

Replacing the forks with paddles, the same equipment is used to stir milk or whey in the vat.

which happened frequently when the granular process was used without starter. (2) The granular process usually makes a cheese of less close and uniform texture. For these reasons the matting process is generally considered a decided improvement over the granular process, in the making of American cheese.

(232) Colby Cheese. A variation in method of manufacture, said to have originated at Colby, Wis., consists in making a granular (231) curd, but after half of the whey is off, adding cold water to the curd to cool it. The cold water is run off immediately, without waiting for any of it to soak into the curd. As the curd drains, it must be stirred vigorously and steadily, to prevent matting. The mechanical curd forker does the stirring easily during draining and salting.

The curd, thus cooled to 90, 80, or 70 degrees in water, requires less stirring to keep it from matting than if it were at 100 degrees, but it is harder to close the curd rind in the press at the lower temperatures. The curd may be salted in a half hour or less after drawing the whey. The cooling of the curd in this way is claimed by some to prevent the development of gas holes

in a curd which might be gassy, if matted and held warm for several hours. Other makers deny this. Colby cheese is classed as American cheese under Wisconsin laws.

Colby cheese must contain at least 50% of fat in the dry matter, and not over 40% moisture; the milk used must be cow milk, and such milk may be adjusted by the separation of part of the fat therefrom, or the addition thereto of cream or skim milk, under federal regulation in force after April 9, 1941.

(233) Washed Curd. Soaked Curd. Federal (U. S.) regulations effective April 9, 1941, state that "the term soaked curd cheese is a common name for washed curd cheese." In a description of washed curd cheese, it is stated that "the milled curd is cooled in water, and soaked therein until the whey is partly extracted and water is absorbed. The curd is drained, salted, stirred and pressed." This process is stated to be in contrast with that for making cheddar cheese, in which the milled curds "may be rinsed by sprinkling or pouring water over them, with free and continuous drainage; but the duration of such rinsing is so limited that only the whey on the surface of such pieces is removed. The curd is salted, stirred, further drained and pressed into forms."

In practice, to wash 500 lbs. of curd, as much as 100 gallons of well water was allowed to run right through the curd, and out at the gate of the vat, stirring the curd constantly, so as to cool every part. Or, in making soaked curd, the cooled curd was left in contact with the cold water, with the gate closed, for a few (3 to 7) minutes before draining.

The regulation of April 9, 1941 requires also that washed curd may contain not more than 42% moisture, nor less than 50% fat in the dry matter, and that the milk used must be cow milk, and permits that "such milk may be adjusted by the separation of part of the fat therefrom, or the addition thereto of cream or skim milk."

(234) Hot Water Washing. Some remarkably fine cheese, winning several prizes, are said to have been made by treating the curd with hot water. This tends also to expel somewhat more moisture from the curd. The curd is softened, mats better and matures faster by being heated, even to 100 degrees. After salting and hooping, it often closes up into a perfectly solid cheese, without any holes at all, giving a candle plug, a firm, waxy texture, a good amber color, and curing faster than if not heated. See also 235A.

(235) Pasteurization in the Cheese Industry. Pasteurization has been applied to milk to curd, and to cured cheese. The pasteurization of milk for cheese making brings the milk day after

day to a practically uniform condition, as to rate of ripening. After adding starter, the details of the making process follow each other with a uniformity as to time schedule not otherwise attainable. The product shows a high degree of uniformity of quality.

In the earliest attempts, difficulties were met in making hard cheese after pasteurization of milk because the milk curdled poorly with rennet, and the curd retained excessive moisture.

Pasteurization at 165° F. The first successful manufacture of American cheese from pasteurized milk was accomplished by Wisconsin Experiment Station investigators.* The killing of tuberculosis germs was the controlling aim, since at that time tuberculosis in dairy cattle was a leading farm problem. Under such control, the use of 165 degrees in the flash pasteurizer (followed by use of hydrochloric acid) was adhered to by Sammis and Bruhn, although they recognized that commercial cheese makers might prefer to use slightly lower temperatures than 165 degrees, in order to avoid the trouble of using hydrochloric acid. These investigators observed that milk pasteurized at 165 degrees, in the machine which they used, did not curdle normally with rennet. They added sufficient hydrochloric acid to the heated and cooled milk to raise its acidity to .25%, calculated as lactic acid, and then added ¾ or 1% of good lactic starter, and added rennet without waiting for ripening.

The milk thus treated curdled so well with rennet that only two ounces of extract were needed, per 1,000 lbs. of milk, and the usual factory fat loss in the whey was reduced almost one-half. It was found that a fixed time schedule for the cheese making operations could be adopted, as for example:—

Operation	Time intervals between operations		Total time after adding rennet	
	Hrs.	Min.	Hrs.	Min.
Adding rennet	0	0	0	0
Cutting the curd	0	25	0	25
Beginning to heat	0	15	0	40
Turning off steam	0	20	0	60
Drawing whey	1	25	2	25
Milling the curd	1	30	3	55
Salting the curd	1	00	4	55
Hooping the curd	0	20	5	15

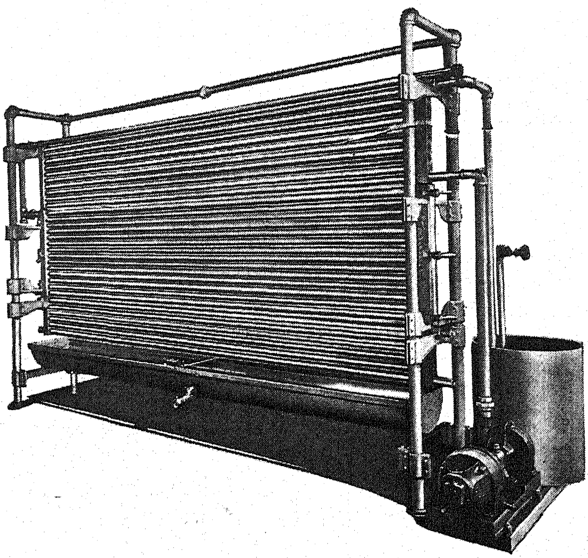
This method of making pasteurized milk cheese was given practical trials by the Wisconsin Station, making 14,394 lbs. of cheese on 142 days during 1912 and 1913, at four commercial

* "The Manufacture of Cheddar Cheese from Pasteurized Milk," Research Bulletin 27, by J. L. Sammis and A. T. Bruhn (1912), Wis. Agric. Expt. Sta. Also, Bulletin 165, Bureau of Animal Industry, U. S. Dept. of Agric.

Wisconsin factories in four counties. In addition, during 1914 and 1915, a firm of Chicago milk dealers manufactured 1,113,-000 lbs. of pasteurized milk cheese by this process at three of their plants, as a means of utilizing surplus milk, with good success.

Other cheese manufacturers, since that date, have preferred to pasteurize the milk at slightly lower temperatures, between 160 and 165, the temperature depending on the length of time before cooling, but always so that the milk curdled well with rennet, and the use of hydrochloric acid was unnecessary and was abandoned.

By 1923, most of the cheese factories in New Zealand were pasteurizing, using regenerative flash pasteurizers, at temper-



Tubular Regenerative Flash Pasteurizer.

atures around 160 degrees since at 155-160 degrees the milk does not lose the power of coagulating with rennet, and no addition of acids or lime salts is necessary. 1 to 2% of starter was added to the milk after pasteurizing.

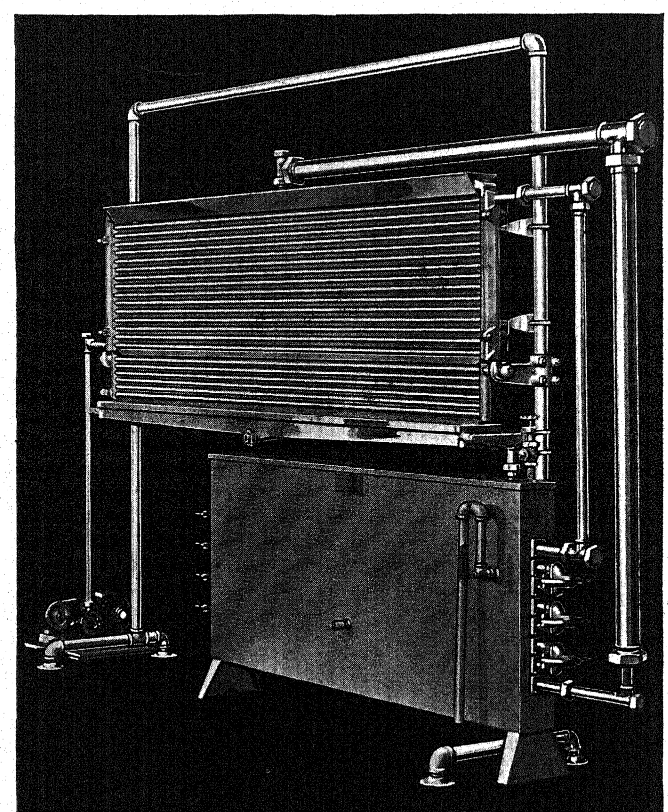
In 1929, favorable reports were received from over fiftv large cheese factories in the United States, pasteurizing milk for American cheese manufacture, in nearly all cases by the flash process.

Opinions on Pasteurization. The National Butter and Cheese Journal sent inquiries in 1936 to cheese makers, state officials,

and agricultural colleges, as to views held on this subject. Replies from fourteen favored pasteurization, three favored it in some cases, and two were opposed to it. See reports from March 10 to Sept. 25, 1936.

A report from Missouri stated, in 1939, that there were 32 cheese factories in Missouri, which receive from 8,000 to 90,000 lbs. milk daily, and practically all of the cheese manufacturers in this state used pasteurized milk.

In 1941, H. L. Wilson (U. S. Dept. Agric.) wrote (Nat. B. and C. Jrnl., Jan. 1941, p. 64): "We believe that a better and more uniform quality of cheese can be made from properly pasteurized milk than from raw milk, regardless of its quality. This is especially true if the milk reduces the methylene blue in less than three hours. The pasteurization of such milk will also result in a larger average yield, because when pasteurized milk



Regenerative Flash Pasteurizer with Tank Heater.

is used, there is no excessive mechanical loss of fat and curd because of fast working curds. Experimental work in the dairy research laboratories of the Bureau of Dairy Industry and in the field indicate that when cheese is properly made from a good quality of pasteurized milk, it will cure more rapidly and satisfactorily at temperatures of from 50 to 60 degrees F., than at lower temperatures."

During the period since 1912, an increasing number of makers have installed flash pasteurizers, and only a very few have quit pasteurizing, after making a start.

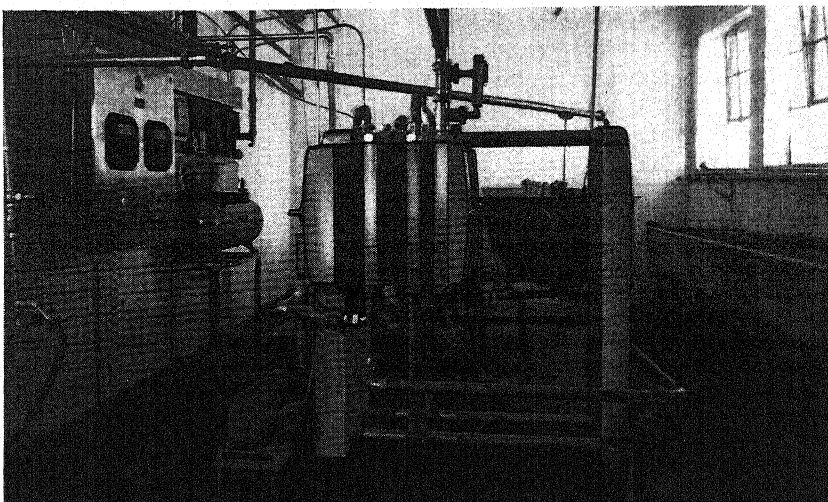
Occasional complaints have been heard that some pasteurized milk cheese had more or less of a bitter flavor, at certain times. When now, using 160 degrees, certain off flavors are noticed, there is always the possibility that the pasteurized milk in the vat was infected by use of an impure starter, or by underheating some of the milk supply as it came through the pasteurizer, or that the milk may have been at times pumped too fast through the machine, and thus cooled too soon.

While the heating of milk to 160 degrees for 15 seconds may be sufficient to kill germs of certain diseases, and to stop lactic acid production, yet it is well known that there are often left in the milk some few bacteria of kinds which are not killed at 160 or 162 degrees, but may be killed at higher temperatures.

It should be noted that in the work done by Sammis and Bruhn, previous to publication in 1912, and in commercial factories, during four years to 1915, with milk pasteurized at 165 degrees, and hydrochloric acid added, no bitter flavor was observed in the cheese. Further explorations of this field are to be hoped for.

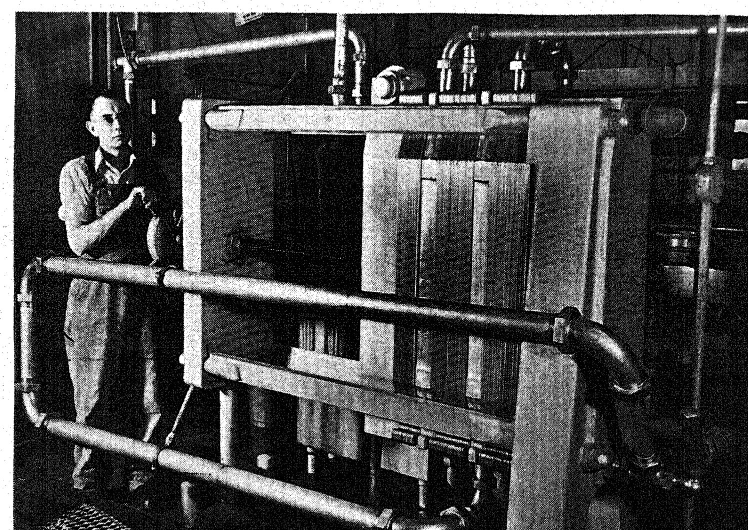
Flash Pasteurization. Modern regenerative flash pasteurizers are widely used among factories having at least 10,000 lbs. of milk daily, because they are most economical, greatly reducing the necessary amount of fuel used for heating, and of cooling water to be pumped. The ingoing stream of cold milk, moving upward inside the pipes, is heated nearly to the pasteurizing temperature by the hot milk flowing downward outside, which is thereby cooled to 86 degrees, or nearly so, for making cheese. The flash method is preferred also because it is most rapid, there being no delay in starting the making of cheese. Only two men are required, one in the intake and one at the pasteurizer.

Plate Type Regenerative Pasteurizers. The more recently developed Plate Type Pasteurizers, now available for cheese factory use, offer among other advantages, completely enclosed arrangements of heating and cooling surfaces and milk conduits, thus excluding dust, etc.



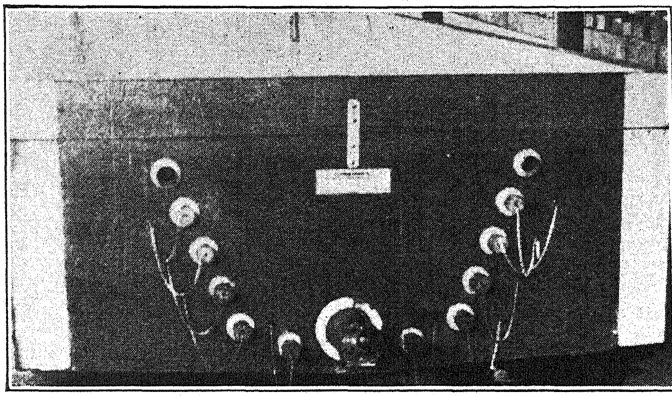
Full-Flow Plate Type Pasteurizer.

Pasteurization in the Cheese Vat. More recently, the smaller, one-man factories have been able to pasteurize, using, not a flash pasteurizer, but a combination cheese vat and holder pasteurizer, first planned by Pauly & Pauly Co., Manitowoc, and built later by several supply firms, in simplified form.



Super Plate Type Pasteurizer.

Pasteurizing can be done in an ordinary cheese vat, if provided with several gates or over flow tubes at different levels, to keep the water level in the jacket no higher than the milk level in the pan, to prevent the pan from floating during the heating or cooling.



Pasteurizing Vat for Cheesemaking.

Using this equipment, the maker weighs in the milk at the intake as usual. With the milk in the vat, he starts the vat agitator, and runs steam into the water filled jacket, until the milk is heated to 145 degrees, at which temperature it is held for 30 minutes. Running cold water into the vat jacket, and starting the agitator again, the milk is cooled to 86 degrees, and is ready for cheesemaking. The extra time required for heating, holding and cooling is 1½ to 2 hours. The quality of cheese obtained by this method is equally satisfactory. In 1928, Price and Prickett reported that the holder process cheese scored 8/10 point higher than the flash pasteurized cheese. (Journal Dairy Science, Vol. XI, page 69.)

The holder method requires that fuel be used for heating all of the milk, and that water be pumped for doing all of the cooling, so that this method is somewhat more expensive to operate than the flash process. It has been used with satisfaction by a number of makers of brick and Limburger cheese in Wisconsin.

A few early references for reading are given here:

"Dairying in New Zealand and Australia," J. A. Ruddick (1923), Bul 34, Dept. of Agric. Ottawa, Canada. "Pasteurization in Cheese Manufacture," C. Stevenson, New Zealand Jour. Agric., Vol. XX, No. 1, page 6 (1920). "The Manufacture of Cheese from Heated Milk," by Niles Benson and R. H. Evans, Journal of the Board of Agriculture, University College, Reading, England. See also J. K. Murray, Journal and Proc. Royal Society of New South Wales (1922), Vol. 56, page 285.

Various Starters Tried With Pasteurized Milk. Most factories use a regular lactic starter in making pasteurized milk cheese.

At the Iowa Station, Lane and Hammer, et al, have tried a variety of other bacteria, and have studied their influence on cheese flavor production. (Research buls. 190, 291.)

Attempts have been made at Wisconsin and elsewhere to improve cheese flavor by adding special starters to milk after pasteurization Geneva, N. Y. Tech bul., 8; J. Dairy Sci. (1940) vol. XXIII, p. 701.

The Cost of Flash Pasteurization. The cost of pasteurization of 6000 lbs. milk daily for 90 days operation in one year, according to observations reported by W. V. Price, (Nat. B. and C. Jrnl., Nov. 10, 1938) is summarized as follows:

Labor, 105 minutes, per day	$ 0.88
Steam, 310 lbs. weight, per day	.31
Water, at $1. per 1000 cu. ft.	.016
Electricity, at 3c per KW, per day	.014
10% annual depreciation, per day	1.11
Total, per day	$ 2.33
Total for 90 days operation	$209.70

5% interest on investment, $50.00.

As a result of pasteurization, there is also estimated, to offset the costs, for 90 days:

Gain in yield, 1026 lbs. @ 14c	$143.64
Gain in quality @ ¾c per lb., per day $4.32; for 16 days	66.10
Total	$209.74

Gain in quality for 74 days, to yield profit.

(235A) Pasteurization of Curd During Manufacture. A process of pasteurizing curd 30 minutes at 145 degrees in the vat during manufacture, devised by Sammis and Germain (Wis. Ann. Rept. 1927-8, p. 23) can be applied to the curd immediately after milling at an acidity of about .6%. To the milled curd spread on the vat bottom is added twice its weight of water at 175 degrees without stirring, and the temperature of the mixture is observed immediately to be very close to 145 degrees. After standing quiet at this temperature for 30 minutes the temperature of the curd is reduced to 90, by addition of cold water, after which the curd is drained, salted, and pressed as usual.

Special care is used not to stir the curd after adding the hot water, in order to avoid unnecessary loss of fat in the water used. Do not use the rake.

The yield was compared with raw curd yields, by weighing out exactly two 10 lb. portions of the milled curd, pasteurizing

one portion, but not the other, and weighing the cheese after pressing. On the average of 21 days trial in 1927, the raw cheese weighed 9.34 lbs. and the cheese pasteurized at 145 degrees 30 minutes weighed 9.19 lbs.

Applying the process to six large vats of curd about April 1, 1928 the raw cheese scored on the average 87.4 on May 1, 87.1 on June 2, and 87.1 on July 2. The pasteurized curds scored 89.0 on May 1, 92.5 on June 2, and 92.2 on July 2.

No special equipment is required other than supplies of hot and cold water. 1929 and later trials were successful, at factories, in cleaning up the flavor of bad-flavored curds.

(235B) **Pasteurization of Cured Cheese, Process Cheese.** As an outgrowth of his earlier methods of sterilizing and canning cured cheese, J. L. Kraft patented his invention of a process for simultaneously heating and stirring finely shredded cured cheddar cheese for the purpose of retaining its normal attractive appearance and flavor, standardizing flavor by blending cheese of different ages, and improving the keeping quality, while also permitting repacking of the product in any desired size and shape, and repacking without rind or moldy surface, for the consumers' use without waste. Other patents cover the addition to the cheese of small proportions of certain somewhat alkaline substances, as sodium citrate, tartrate, or phosphate, to enable the cheese to be melted at somewhat lower temperatures, and to keep the fat emulsified. Cheese of a variety of flavors, as American, Swiss, brick, Limburger, Camembert, Old English, etc., have thus been placed on the market. Batch methods of heating in steam jacketed kettles, or continuous methods of heating cheese during passage through the special equipment are used by firms. who have purchased rights under the existing patents. The marketing of this cheese in five-pound sizes and smaller packages has made cheese in a variety of kinds available in world-wide commerce.

Wisconsin Res. Bul. 137 (1939) summarizes the status of a list of patents concerned with cheese processing and packaging, outlines the more important factors to be considered, and explains the major technical steps involved. It is estimated that about one-third of all the cheese consumed in the United States is processed. Mild flavor, smooth texture, and a body slicing without stickiness or crumbliness, and uniformity are attractive characteristics. Packaging, labeling and advertising are important aids.

The expiration of eight patents and two reissues leaves available to the public (1) selecting for blending, (2) trimming, grinding, heating (to from 120 to 240° F.), (3) addition of phos-

phates, (4) addition of citrates, and (5) packaging in foil-lined containers. For other features, existing patents should be studied, since they cover special processes and machines.

From the Wisconsin bulletin referred to above, a few selected paragraphs are quoted here, of special interest to factory cheese makers, who may consider making process cheese.

"While a processing venture can be started with a limited investment in equipment, and while the processing operations can easily be learned, successful operation requires a relatively large investment in a stock of cheese. Furthermore, while processing is relatively easy, successful marketing may be difficult. Present manufacturers in most cases advertise extensively, and have distributing organizations. They carry an extensive variety of cheeses and other products, and provide for frequent delivery to retailers in order to maintain fresh stock on their counters. Certainly no processing venture should be undertaken without first giving considerable thought and study to a marketing or merchandising program.

"**Cheese Processing Procedure.** The steps in the processing of cheese are: (1) selecting the cheese, (2) trimming and grinding, (3) heating to 145° to 160° F. with stirring and with additions of water, emulsifying agent and possibly seasoning, and (4) packaging the hot, semi-fluid mixture.

"**Selecting the Cheese.** Obviously the cheese must be so selected that the finished product is in compliance with legal standards. Selection for processability is highly important in making "pasteurized cheese" (federal definition), but when emulsifying salts are used, this consideration is of minor importance.

In selecting cheese for blending it is necessary to have a flavor standard in mind. It has been general practice to blend so as to obtain a product with a moderately mild flavor. While indications are that the majority of consumers prefer a mild flavor, a further reason for this practice is the economy resulting from the use of younger cheese.

The desired flavor is usually attained by mixing a preponderance of young cheese with well-ripened cheese. There are several reasons why this practice is favored over the use of medium aged cheese throughout. Where young and old cheese are combined the average age (storage time) required to produce a given flavor is less than where a similar flavor intensity is obtained by using only medium ripened cheese. Further, a more typical and desirable flavor can be obtained by deriving it from well ripened cheese that was originally selected because of its curing properties, and diluting it with young cheese. This prac-

tice offers the opportunity to use up young cheese of poor curing properties before definite flavor defects become evident. Thus in a well-operated processing plant the selection of cheeses is not confined only to the lots to be processed each day, but is applied regularly to all the cheese in stock to cull out lots that are not suited for advanced ripening.

"The selection of cheese has some effect on the texture, body and slicing properties of the finished product. Relatively young cheese imparts a smooth texture, firm body and good slicing properties. Older cheese tends toward a grainy texture, weak body and poor slicing properties. High acid cheese tends to produce a grainy texture. For this reason, and because of flavor, it is blended in small amounts with cheese of normal acidity. In general it may be said that young cheese is used to impart desirable texture, body and slicing properties, and older cheese is used to impart the desired flavor.

"The exact proportions in which the cheeses are blended depend upon their age and flavor, and upon the standard desired. Usually approximately 75% of the blend consists of cheese up to three months old, and the rest consists of cheese six to twelve months old. The person who selects for blending must use judgment and must be thoroughly familiar with the lots in storage in order to make the wisest use of them.

"Cheeses with physical imperfections such as blind Swiss cheese, Swiss cheese with broken rind, cheese damaged in handling, and cheese that has been invaded by mold because of imperfect sealing after plugging can be salvaged by processing. This fact, plus the fact that the processed cheese industry can utilize cheese **which would become defective** when ripened for retailing as bulk cheese, is apparently the basis for the unjustified accusation sometimes made that processed cheese is manufactured from cull and inferior cheese. However, it should be remembered that in processing, damaged parts can readily be removed by trimming, and that cheese of a type which experience has taught will become defective on ripening can be used before it really becomes defective. In this manner salvaging is possible without any adverse effect on the wholesomeness or quality of the processed cheese. Actually such salvaging is a minor part of the processed cheese industry, which must be evident when its volume is considered in relation to the total cheese produced.

"**Selecting for Composition.** In selecting cheese for processing, consideration must be given to its composition and to additions to be made. Emulsifying salts, and possibly seasoning materials added in processing will increase the dry matter without increasing the milk fat content. The fat content in the water-

free substance of the original cheese must therefore be sufficiently in excess of the minimum standard so that the processed cheese will still be above this minimum in spite of such additions. Cheese that is near the minimum fat content must be combined with enough richer cheese to attain this result. Similar consideration must be given to the moisture content. Emulsifying salts contain water as moisture or as water of crystallization. Seasoning material such as pimientos contain water. The moisture content of the cheese and the water contained in any additions must be known in order to be sure that the maximum permissible moisture content is not exceeded, or in order to compute the amount of water that may be safely added as such. Usually the conditions are such that some water may be added. By combining low moisture cheese with high moisture cheese this offers a convenient market for the latter, which as bulk cheese might have to be sold under the stigma of a label calling attention to its excessive moisture content. This again is a minor question, but does represent a fortunate outlet for cheese with excessive moisture content, for which the cheese industry should be thankful.

"The aim in blending is to secure uniformity of flavor, body and texture, and composition, in conformity to law.

After trimming and grinding, the processing in kettle or continuous machine brings the cheese to a semi-fluid condition, smooth in texture and homogeneous throughout, at a temperature of 150° F., (or 160-170 for soft cheese or cheese spreads) and ready for packaging. Minimum costs are estimated in the bulletin.

Federal and Wisconsin legal standards are given, for processed cheese and for cheese food compounds, including cheese spreads. Lack of experience and training on the part of new manufacturers, or lack of adequate stocks of cheese from which to select for blending may result in financial loss to the operator, and prove a detriment to the industry.

Information reported by the Charles R. Barker Service Bureau for Process Cheese Manufacturers, 803 N. Humphrey Ave., Oak Park, Ill. based on the experience of several plants now in operation indicates that a weekly output of 20,000 lbs. of processed cheese will require six people, three men and three girls employed in the plant. The labor cost might be ½ to 1 cent per lb., and the entire cost of processing 1 to 2 cents per lb. The stock of cheese carried might be 160,000 lbs. The equipment may cost about $2500. The profit may possibly be 1 cent per lb. above all costs. The necessary floor space for the make room may be about 40 by 30 feet. Near-by cold storage is essential. Laboratory equipment and skill is necessary for accurate testing of cheese materials and products for fat, moisture, acidity, etc. As for any

enterprise, the available market for distribution of the product. the cost of packaging, labeling, advertising and sales promotion should be considered in estimating the capital required.

A series of articles in the National Butter and Cheese Journal beginning October 1939 briefly describes kettle and continuous machines, use of emulsifiers, batches, blends, acidity, temperatures, packaging, testing, supervision, etc.

(235C) Cheese Compounds and Spreads. Since the development of the melting process (235B) several cheese compounds have been placed on the market which resemble cheese in appearance but can not lawfully be labelled cheese, because of their high moisture and low fat content. By evaporating whey in a vacuum pan (neutralizing it to about .07% acidity) a pasty mass of whey solids is obtained which can be stirred into melted cheese, to produce cheese-like products, which are widely sold in the market in half pound and smaller packages. On account of the high moisture content, such products must be sold and eaten promptly.

Cheese spreads are of higher moisture content so as to spread but not slice, and are packed in glass jars or bottles. The base of a spread may be mixtures of cream cheese, Neufchatel, Coulommier, cottage cheese, skim milk powder, whey powder, etc., to which may be added flavoring materials in small quantities as Limburger, Camembert, pickles, olives, pimientos, with emulsifiers, and stabilizing gums, as tragacanth, gelatine, etc. The well mixed blend is finally heated to about 170, or a temperature which will not injure the flavor. The acidity of the blend should be tested and controlled, by addition of an acid if necessary, as citric or phosphoric. Upon the acidity depends the keeping quality of these products, to a great extent. (Nat. B. & C. Jrnl., Jan. 1940, p. 13; June 1940, p. 26.) 309A. Wis. Res. bul. 137.

(235D) Clarified Milk Cheese. Bulletin 418 from the Cornell Station in 1923 showed a reduction of gas production, and a general average increase of score of 1.8 points in quality of American cheese, as a result of clarification experiments by W. W. Fisk. Pa. bul. 188; Tech. Bul. 104, N. Y. (204)

(236) Skim Milk American Cheese. Cheese prices must go unusually high, in order that the income from the making of skim milk cheese at a creamery may exceed the feeding value of the skim milk for live stock. The cost for equipment, supplies and labor is about the same as for making whole milk American cheese; the market is limited, very few dealers handling skim cheese; and the demand from consumers is small.

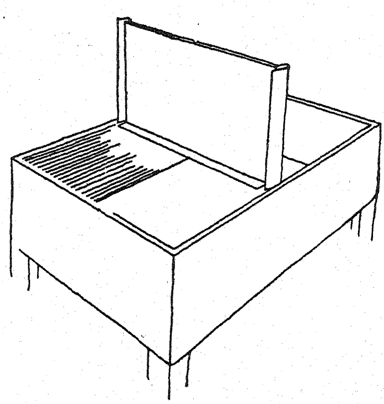
Small factories can not keep both a cheesemaker and a buttermaker busy, and large creameries are likely to undertake the manufacture of skim cheese only under exceptional conditions. Casein and butter making may be more profitable, and is always lawful.

Viewed from the standpoint of the dairy industry, the making of skim milk cheese is likely to be a detriment, unless safeguards are provided to avoid the suspicion that unscrupulous dealers may substitute skim cheese for whole milk cheese in the markets.

(237) Laws Relating to Skim Milk Cheese. Tabular statements of the standards for dairy products established by law in different states are published by the U. S. Dept. of Agr., Washington, D. C. In the majority of cases cheese containing less than 50 per cent of fat in the dry matter are classed as skim milk cheese.

While some states require skim cheese to be so labeled on the bandage, yet such labels are readily removed, and consumers are always likely to suspect that any cheese from such states are made in part or wholly from skim milk, and have been fraudulently substituted for whole milk cheese in the market.

Since 1898, in the State of Wisconsin, the law has required that all skim or part skim American cheese shall be made 10 inches in diameter and 9 inches in height, so as readily to be recognized and distinguished in the markets from whole milk



Movable Partition for Dividing Cheese Vat. The sheet metal flanges on the sides and bottom of the partition are bent to fit the vat snugly. The partition remains firmly in place while the color is being stirred in, and can be lifted out with ease after the milk has thickened.

cheese, which are never made in this size and shape. As a result, no skim milk cheese have been made at American cheese factories in Wisconsin for many years, and the state's industry

is fully protected by this law both from fraud and suspicion of fraud. So more effective method of distinguishing and labeling skim milk cheese has been devised than the one just described.

There appears to be no way at present by which skim milk cheese can be made or kept in exactly the shape and size required by law in Wisconsin, on account of shrinkage, etc., unless considerable tolerance is allowed.

Another effective method of unmistakably marking skim milk cheese, devised at the Wisconsin station in 1918, consists of adding 1 ounce of cheese color per thousand pounds of milk in the vat, to about 1/10 of the vat content, just after adding rennet, and before the milk has begun to thicken. For this purpose, a movable partition is temporarily placed in the milk near one end of the vat after adding rennet, and the regular cheese color is stirred into the small portion of the milk behind the partition. After all the milk has thickened, the partition is carefully lifted out. Thus without extra cost or trouble the cheese is effectively labeled with a speckled pattern through the interior which is striking, attractive, not at all repulsive in appearance and which can never be removed from the cheese. The colored curd can also be made in a separate vat. It is possible that skim milk cheese thus marked might be made in any convenient size and shape used for whole milk cheese, if permitted by law, without danger of fraudulent substitution.

(238) Methods of Making Skim Milk American Cheese. In making skim milk cheese, care must be used not to get it hard and tough. It may be made much the same as a high moisture whole milk cheese.

With separator skim milk to start with, this may be ripened to .24% with 5 to 8 lbs. of starter, and set at 84-86 degrees with rennet extract, so as to cut in 30 minutes. After cutting, the curd is stirred by hand for a time, without raising the temperature, and a part of the whey is drawn out. When the curd has become firm enough, as judged by the feeling of handful, so that it can be piled up on the bottom of the vat, and not run down like wet mortar, and so that the curd will drain and mat well without collecting around the strainer and clogging it, the remainder of the whey is drawn, and the curd is piled up to mat.

If the milk is sweeter than suggested above, a longer time will be required to get the curd firm before drawing the whey, and the vat may have to be heated after cutting.

The piled curd mats rapidly, and is soon cut into blocks and turned. Half an hour after drawing whey, the curd can be milled without danger of shattering, and a few minutes later it is salted, and as soon as the salt has dissolved, the curd is hooped.

Just after milling, and before salting, the curd may be rinsed with cold water to cool it and prevent it from becoming too dry. One to 1½ lbs of salt per 100 of curd is used, and the pressed cheese should be paraffined as soon as the surface is dry. They may be ripened for 30 days at about 70 degrees.

The important matter in making a skim milk cheese is not to get it so dry as to be tough. The color should be very translucent and the moisture percentage is of course very much higher than for whole milk cheese, due to the absence of fat.

With half skimmed milk, containing about 2 per cent fat, the process is intermediate between that for whole milk and for separator skim milk. With 2 or 3 lbs. of starter per 100 of milk, it may be ripened to about .22% and set to cut in 20-30 minutes, at 84-86 degrees.

After cutting, the vat is gradually heated to about 92 F., and as soon as the curd is elastic and drains well, which may take 30 minutes or longer, the whey is drawn at about .18% acidity, and the curd is matted. It is cut into strips and turned. When well matted and meaty in texture, as with whole milk cheese, it is milled, salted with 1½-2% of salt, and hooped. Skim milk casein differs from whole milk casein (172A).

(239) Monterey Cheese: Jack Cheese. The first name is derived from Monterey county, California, where its manufacture was first taken up on a commercial scale about 1916. Previous to that time, it had been made by Portuguese farmers in California, often from the milk of a single cow or small herd on the farm, either from whole milk, or sometimes from half skim milk. In the latter case it is grated for use, like Parmesan, Sap Sago, and other very dry skim milk cheese.

The process employed with whole milk is practically the same as the granular process described above (231) but the curd is salted while yet warm, being stirred only a short time after drawing the whey. It is finally pressed in a cloth bag, giving it a peculiar shape.

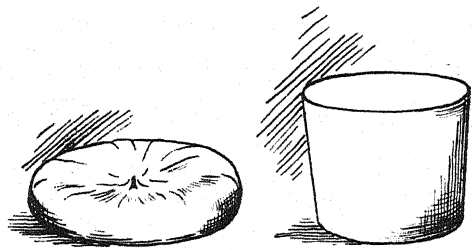
(240) Method of Making Jack Cheese.* The mixed milk should not test higher than .16% acidity and should have a clean flavor. Standardize to 3.1 or 3.2% fat. Heat to 86 degrees F. and add ½ to 1% commercial starter or clabbered milk. Add sufficient rennet (about 6 oz. per 1,000 lbs. milk) to curdle the milk ready for cutting in 25 minutes. Stir the curd sufficiently during the cooking process to prevent matting. The heat should be applied ten minutes after cutting and the temperature raised to about 110 to 112 degrees F. in 35 minutes or at the rate of

* Private communication to the author from Prof H. J. Baird, University of California.

about 3½ degrees in five minutes. Thirty-five to 40 minutes after it reaches the maximum temperature the curd should be slightly rubbery but not so firm as curd for Cheddar cheese. The whey is removed and the curd stirred sufficiently to remove the excess whey. Too much stirring makes it too dry. Salt is added while the curd is warm at the rate of 3 lbs, per 1,000 lbs. milk and after it is thoroughly mixed and dissolved the curd is ready to press. Cal. Circ. 13.

The press cloths, of heavy sheeting about 34 inches square, are laid out evenly, one over the other, and are spread over the top of a large open pail. Push the center down to the bottom of the pail leaving the edges hanging over the sides. Sufficient curd (about 7 lbs.) to make a six pound cheese is weighed out and poured into the top press cloth. The four corners of the cloth are caught up with the left hand, while with the right hand the curd is formed round and the cloth straightened. The cloth is now taken up tightly over the curd with the left hand, while the cheese is given a rolling motion on the table, with the right hand pressing at the same time to expel the whey. This twists the press cloth tightly over the curd, where it is tied with a string. The excess cloth is spread out evenly over the top of the cheese and it is then ready for the press.

The cheese are pressed between two wooden planks or in an ordinary upright cheese press. In about two days after removing



Jack Cheese pressed in cloth (at left). Home Made Cheese pressed in a lard pail (at right).

from the press the cheese should be dipped in hot (200 to 220 degrees F.) paraffine and held there for 10 seconds. This will prevent shrinkage and gives the cheese a neater appearance.

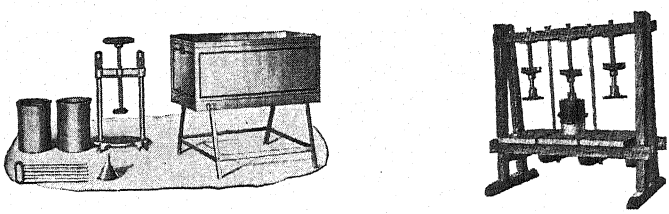
(241) Half Skim Jack Cheese. Milk used for half skim Jack Cheese should test 1.8 to 2% fat. The night's milk may be skimmed and the skim milk mixed with an equal amount of morning's whole milk. The rate of rennet extract should be decreased sufficiently to curdle the milk ready for cutting in about 45 minutes. The cooking temperature should be lower, about

104 to 106 degrees F., and the whey should be removed when the curd is about the same firmness as for full cream Jack. The cheese should not be paraffined as they are usually dried for grating purposes.

(242) Home-Made American Cheese. In the early days of the cheese industry in this country, cheese was made at home on the farms, from the milk of a few cows or goats, by the farmer or some member of his family.

In general, almost any kind of cheese can be made at home on the small scale, following the same methods used in factories, as described in this book.

A family cheesemaking outfit can be rigged up at home if the process is well understood, but a small, complete outfit can be purchased from dealers. Where cheese is made at home, provision for curing in a moderately cool place must be made. The The cheese may be paraffined or rubbed with grease on the rind to prevent cracking, and kept in a cool cellar, or well, for curing until used.



Home cheesemaking equipment.

In cutting cheese, keep the cut surface flat and smooth, and turn it down on a clean plate to prevent drying out, or cover it with waxed paper or a cloth wet with salt brine, or simply grease the cut surface with butter, each time it is cut. If it gets moldy, this is due to being kept in too damp a place.

Home made cheese may also be made and pressed like Jack cheese (240). Farmers bul. 1191, 1734.

(242A) Camosun Cheese. This home made cheese is well described in Washington State Col. Bul. 175. (1934)

(243) Pineapple Cheese. This is a rather firm make of American cheese, put up in pineapple form, and made for many years by one or two eastern factories. The curd is pressed in a hinged iron mould, which marks the surface, as seen in the market.

(244) Sage Cheese. This is made like American cheese, but with a green speckled color and a sage flavor. About one

sixth of the milk in a small vat, or behind a partition (237) in the big vat, is colored by adding a harmless color paste, or tea made from corn, clover or spinach leaves. The two curds must not be mixed until just before drawing off the whey.

The flavor is either sage tea or sage extract sprayed on the curd, just before salting, and while stirring well. Sage tea is best.

For 100 lbs. curd, use 1 ounce of extract or 3 ounces of leaves for tea.

Formerly, dried sage leaves were mixed into the curd before salting, to give both flavor and a speckled appearance to the curd. But the pieces of leaf decayed and turned yellow, if the cheese was held for long curing. Mich bul. 21; Farmers bul. 202.

(245) Pimiento Cheese. In a similar way, canned pimiento is sometimes ground in a food chopper and added to American cheese curd after salting, so that the red color is distributed unevenly throughout the cheese and the flavor is noticeable in all parts after curing. The pimiento is a sweet pepper, with a fleshy pod, grown in Spain, California, Ohio, and in a few other localities. It is canned like other vegetables for the market.

(246) Club Cheese and Similar Preparations. Club cheese is made by running well cured American cheese through a grinder or mill, reducing it to a smooth paste, and mixing in a certain amount of butter with or without other flavoring materials. About 1 ounce of butter to a pound of cheese is a fair proportion, but somewhat more or less can be used.

The stronger flavored and older cheese are preferred for making club cheese. An old cheese partly damaged by mold in the interior and bought at a reduced price can be cleaned by cutting out the moldy portions and the remainder is often very satisfactory for club cheese. The product is packed in 3 lb. or smaller jars. It spreads on bread easily.

Club cheese containing more or less butter is ofter flavored with pepper, either black pepper or a red pepper as cayenne, pimiento, or paprika. If colored green and with a peppery flavor, it is known as chili cheese, and by a variety of trade names.

(247) Canned Cheese. Prior to the invention of "process" cheese, canned cheese was thoroughly sterilized by use of a high temperature, which often injured the flavor, but prevented swelling of the cans. In more recent years, a few factories have sealed curd from the press in cans, but the natural slow emission of carbon dioxide gas from the curd developed pressure and caused the cans to swell and burst or leak. Swelling was later avoided by allowing the gas to escape through a small check valve on each can. (U. S. Dept. Agric. Bureau of Dairy Ind.)

The question remains as to whether the housewife will prefer to buy cheese in a can and use a can opener. Since cured cheese often show defects in flavor not noticed in the milk or curd, the difficult problem remains of selecting for canning only such curd as will certainly show a good flavor quality after the can is opened. To meet this requirement, Wilson suggested that pasteurized milk cheese be used for canning. Nat. B. and C. Jrnl., Jan. 1941, p. 64.

(248) Loaf Cheese. A method for the manufacture of family size American cheese, weighing 1 to 5 lbs. has long been sought. Cured cheese have been ground up, worked by machinery into a plastic mass, pushed through a shaped tube, and cut off in pound bricks, packed for family use in cartons. The cheese often gets moldy in the carton. Excessive shrinkage and waste of rind, and the labor of making and curing many small loaves, were the first serious obstacles.

Later cheese were pressed in 100 lb. cubes, and after curing were cut up with knives into 1 or 2 lb. blocks, which were either paraffined or wrapped in scored scale board, etc., for packing and shipment. This plan avoided undue shrinkage and labor in curing, but did not wholly avoid a moldy surface on the cheese at the retail counter.

More recently, half a dozen or more small cheese can be pressed in one of the new "multiple" hoops, and the attempt has been made to dry the surface for a few hours, and apply a wrapping or coating in which the cheese could be cured and delivered to the customer, attractive in appearance and entirely free from mold on the surface, and without rind to be wasted. A variety of varnish or lacquer coatings, and paper or metal foil wrappings have been tried. Among the latest offered are parafilm, pliofilm, cellophane, etc.

The problem is difficult. An apparently dry, but rindless, block of curd contains 35% or more of water, and numerous bacteria and mold spores. As mold requires air for its growth, the wrapping must be impervious to air, free from danger of pin holes or tearing, and must fit tightly to the cheese surface without air bubbles, after pressing. The wrapping must be practically impervious to moisture exuding from the cheese surface. There is finally the possibility that on the surface of the rindless cheese, under the wrapper, anaerobic bacteria may produce odors resembling Limburger cheese, after curing for six or eight weeks.

(248A) White Cheese. The natural cream color of cheese, which occurs when cows are on pasture, may be reduced by use of less green feeds. In Europe, small amounts of "decolorizer"

have been added to milk, to produce "white" cheese. (Hansen's Dairy Bulletin, April, 1937)

(248B) Smoked Cheese. The Dairy Industry Department of Iowa State College at Ames, Iowa, has contributed a successful method of making smoked cheese.

The main problem in the smoking of cheese is to maintain a low temperature so that the body and texture will not be injured by melting. The apparatus to overcome this difficulty consists of two chambers. In one, hickory kindling is burned to furnish smoke which is piped to a second chamber which contains the cheese. Room temperature is maintained in this chamber during the 24 hour period of smoking the cheese. Not over 100, F.

Since the smoking process makes undesirable flavors more evident, the original cheese must be of excellent quality. A five months old cheddar cheese is cut into half pound slabs, wrapped in parchment, and put into the smoking chamber. At the end of the smoking period, it is taken out, re-wrapped in cellophane, and is ready for market. (Nat. B. & C. Jrnl., Aug., 1940, p. 65.)

The use of "liquid smoke" to impart a smoked flavor to cheddar or provolono cheese was reported by J. C. Marquardt (N. Y. Sta.) Liquid smoke is sold as "Pyroligeneous Acid" distilled by E. W. Cooledge Inc., 300 Madison Ave., New York City.

The liquid smoke could not be satisfactorily added to the curds. The additions to the milk, and the whey just after cutting, were successful.

The addition to milk of .02 per cent of liquid smoke or less produced a desirable smoked flavor in cheddar type cheeses. It was not desirable to add more than .1 per cent of liquid smoke.

The addition of .01 per cent of liquid smoke to processed cheese imparted a pleasant smoked flavor to resulting cheese.

CHAPTER XXIX.

Details of American Cheesemaking Process

Intake Work. The inspection and testing of milk at the intake have been described in Chapter 3. As a result, the maker knows what kind of milk he has in the vat to work with today.

(249) Ripening of Milk. Read Chapter 4 for general facts about bacteria, and starters.

At the factory, the acidimeter test of fresh, unripened milk (morning milk) is low (perhaps .15%) and is due to the casein, mineral salts, etc., present in all milk. The acidimeter test of ripened milk (night milk) is higher (perhaps .17%) and the increase is due to lactic acid produced by bacteria. With fresh milk, the rennet test may be 4 spaces, with ripened milk 2 or 3 spaces.

The importance of the presence of this small amount of lactic acid arises (1) because a little acid tends to check the growth and activity of gas-producing bacteria in the curd, and (2) it promotes the separation of whey from curd, after the curd has been cut.

Without starter or lactic acid, the old time cheesemaker made a large proportion of gassy cheese. Without some lactic acid, the present day maker of export (dry) American cheese or of Swiss cheese cannot get his curd as dry and firm as it should be, before the whey is drawn off. To ensure the presence of some lactic acid bacteria, and the development of some lactic acid in the curd, makers of American cheese quite generally add about 1% of good starter (25) (33) to the vat, as soon as part or all of the milk is in.

With sweet or slow ripening milk, the starter may be added to the vat with the first milk received, and the vat kept warm, about 80-85 degrees, F., to promote ripening. Also, read (25A), as to age starter, when added to vat milk.

With ripe or overripe milk in the vat, the starter may be added when all the milk has been received, after which the vat is warmed to 86, F., and rennet is added immediately.

The maker may like to see, by making tests at short intervals, that acidity is increasing in the milk, before he adds rennet to the vat. He may prefer to let the acidity develop in the milk up to a certain point (such as 2 spaces on the rennet test) before adding rennet. This he calls "ripening the milk," before setting.

Other makers, having added starter to the vat of milk, feel sure that the ripening will go on in the milk or curd equally fast whether rennet is added or not. They omit any ripening period. After adding starter, they are ready immediately to heat up the vat, and add rennet to any vat of mixed night and morning milk. This practise tends to increase.

The general aim is to do the work so that the desired degree of acidity in the whey will be reached at the same time as the desired firmness of curd, thus avoiding all emergency methods in drawing the whey.

At a new factory, on the first day, the milk may be ripened to .175% acidity before adding rennet, and its behaviour watched closely afterwards, from which the maker may decide to ripen differently on the following day. No two days are alike, unless the milk has been pasteurized.

(250) Keeping a Make Room Record. Makers who keep a record of the time required to complete each step in the process on different days, and study the reasons for differences from day to day, find that it helps them to understand the whole process of making, and the differences in cheese quality from day to day, and to promote greater uniformity of quality.

(251) Adding Color. Cheese color (61A) is commonly added to the milk at the rate of about ¼ ounce per thousand pounds in summer, or 1 ounce per thousand in winter. When cows are on grass the milk has nearly enough color naturally. White or uncolored cheese are made only when the factory has received an order for such cheese in advance. When not specified as white, it is assumed that cheese will be colored.

Where the rennet test is used at the factory, the color should be added to the milk before the first rennet test is made, to avoid having lumps of white curd from the rennet test mixed through the colored cheese.

Where the acidimeter is used in testing the ripeness of milk, it is better not to add color to the vat until the milk is fully ripened and ready to add rennet, because the cheese color in milk gives it a slight reddish tinge, so that the end point of the acidimeter test is not so readily seen.

Color may be added to the milk in the vat without first diluting with water. In stirring in color, it is well to observe in some way how much stirring is necessary to distribute the color evenly, by observing how many minutes are spent in stirring, or how many times the rake is pushed across the vat, or how many times the maker walks the length of the vat before the color appears to be evenly mixed. This gives an indication as to how long the milk should be stirred after adding rennet extract, which is the next step.

(252) Adding Rennet. Before adding rennet, see that the steam valve is closed and does not leak, and wait five minutes or more for steam in the jacket to condense. Rennet extract at the rate of 3 or 4 ounces (133) per thousand pounds of milk is measured in a separate graduate. One ounce equals about 30 c.c.

The quantity of rennet should be such as to thicken the milk, ready to cut, in 25-30 minutes. If it thickens faster, the curd gets too tough before the cutting can be completed with ordinary curd knives. (256)

The measured rennet extract or pepsin solution is poured first into clean cool water. The quantity of water for 5,000 lbs. of milk may be one or two pails, equal to ½ or 1% of the milk. After mixing the extract through the water, set the pail down near the vat. Set the milk in motion either with the agitators, or by stirring crossways with the rake. (Stirring lengthways is likely to cause high waves, and throw the milk over the end of the vat.) While the milk is in motion, pour from the pail along the middle of the vat, while walking briskly along the side, so as to distribute the extract evenly from one end to the other. With 10,000 lbs. in a vat, use two pails, one at each end. Quickly take up the rake, if used, and stir again across the vat, while walking 2 or 3 times along the length of the vat, so that the rennet is evenly distributed in the milk as quickly as possible and within 2 or 3 minutes after the addition is made. Empty the gate.

Rapid work is needful, because the milk is likely to begin to thicken in 8 minutes after adding rennet, and if three minutes are required to complete the stirring, there will be only five minutes left during which the milk must become perfectly quiet, before the first visible thickening occurs. If milk is moving or is stirred after it has begun to thicken, there is likely to be a loss of fat in the whey, dry texture and loss of yield.

During the thickening, for the same reason, the milk should not be jarred by anyone leaning against the vat, by heavy walking across the floor or by moving machinery, etc. Cover the vat to keep the milk surface warm (7) (206).

(253) Top Stirring. If milk will require more than 8 minutes before first visible thickening, it may be top stirred by running lightly over the surface of the milk with a rake or dipper about 2 or 3 minutes before it is expected to thicken, to stir down cream, but so as to allow the milk to become quiet again, before thickening occurs. Before top stirring, make sure that thickening has not already begun.

(254) First Visible Thickening. It is an advantage, in many cases, to note by the watch the exact time when rennet was add-

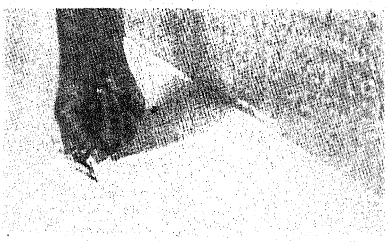
ed and again the time when the milk shows the first sign of becoming thick. The first sign of thickening can be detected either (1) by lowering a horizontally held thermometer or finger below the surface of the milk, which will cause a visible depression in the surface, as soon as thickening occurs, or (2) by dipping a glass tube or glass plate into the milk at short intervals, lifting it out quickly and looking to see whether the film of milk adhering to the glass contains small granular particles, which will be visible as soon as coagulation begins.

If a vat of milk requires, for example, 10 minutes after adding rennet before the first visible thickening occurs, the maker can expect that the curd will be quite firm and ready to cut in about 2½ or 3 times 10 minutes, that is, 25 or 30 minutes after rennet was added. By knowing this rule, he can go ahead with other work, and return to the vat at just about the right time for cutting.

(255) When Curd is Thick Enough to Cut. If a curd is cut when very soft, the whey which separates is likely to be somewhat white and milky, showing an unnecessary loss of fat and perhaps of casein. Also a very soft curd is more likely to be broken and mashed during the stirring after cutting, causing further loss. For cutting very fine as with a ¼ inch knife, the curd should be cut rather soft.

If long splits occur in the vat of curd, this indicates that the rennet was not evenly distributed, or stirred too long.

Before cutting, cheesemakers split the curd with a finger or a thermometer, and look to see if the whey in the break is clear, not milky, also whether the break shows a lot of finely



Testing curd for thickness over the finger.

broken curd which sticks to the finger, or not. If well thickened, the whey is clear, and without broken pieces of curd.

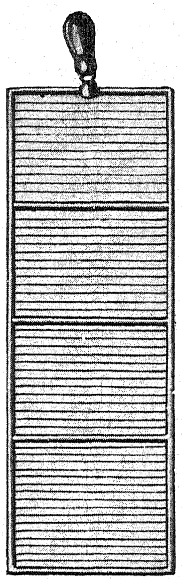
Other tests may be used just before cutting the curd. Some makers lay the back of the hand on the curd close to one side of the vat, and by a sideward motion try to pull the curd away from

the tin. If it splits away from the tin readily, it is firm enough to cut (209).

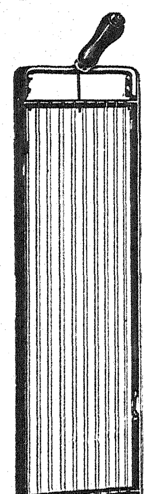
If the curd is cut when too firm, it is much harder work to push the knife along. If the curd pushes ahead of the knife, move the knife faster.

By laying the back of the hand on the curd in the middle of the vat, and pressing down, the firmness of the curd can be judged. On moving the hand up and down, so as to shake the curd and cause ripples, it will be noticed that when the curd is quite soft, the ripples will travel several feet across the curd surface, but when quite firm and ready to cut, the ripples will not move farther than one foot from the hand. Each maker prefers one of these tests or another, and students may try all of them.

(256) Cutting Curd with the Horizontal Knife. Rest the upper end of the horizontal blade or wire curd knife against the near upper edge of the vat end, with the knife held nearly horizontal; swing the knife downward into the curd, with a motion like that of a falling pendulum, the knife stopping against the end of the vat and just touching the vat bottom. In this way the knife is inserted with a cutting motion and without breaking or mashing the curd. The second movement of this knife carries it along the length of the vat, close to the side, to the opposite end. The third movement swings the knife around (like a door) in the curd, ready to move down the length of the vat toward the first end. Each lengthwise cut is made as close as possible to the edge of the preceding cut without lapping.



Horizontal Wire Curd Knife.



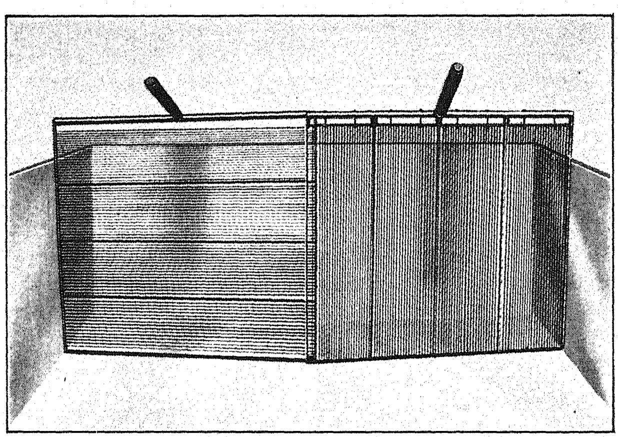
Vertical Wire Curd Knife.

In this way, turning the knife at the ends of the vat, and cutting forward and backward the long way of the vat, the curd is all cut into horizontal layers, like blankets on a bed, and the knife is finally taken out by a pendulum-like motion the reverse of that with which it entered the vat. When making the last cut lengthwise of the vat, it may happen that the curd mass is slightly wider than the curd knife. In such case, cut next to the side of the vat, leaving a narrow strip of uncut curd between this last cut and the preceding one.

(257) Cutting Curd with Vertical Knife. Holding the vertical knife in the right hand, put the left hand on the vat end, reach across with the knife and insert it into the vat without mashing the curd, and cut across the width of the vat. The knife is taken out at the end of each cut, moved along its width toward the right and put into the curd again. The position of the knife while moving across the vat is straight up, but while going in or out of the curd, the handle of the knife is tipped away from the side of the vat, so that the cross bar at the bottom end of the knife does not mash curd while moving up or down.

After cutting crossways of the vat with the vertical knife, the curd is next cut lengthways with the same knife and in the same manner. Three-eighths inch wire knives have largely replaced the ½ inch blade knives in recent years, as they cut finer, are much lighter in weight, and with proper care the wires seldom break. The object of cutting is to divide the curd into small uniform cubes. ¼ inch knives are used in Canada and by many Wisconsin makers.

(257A) Big Knife Pairs. By use of a pair of these large wire knives, the entire vat of curd is cut most quickly and evenly by two men, using both knives at the same time, twice, lengthwise of the vat. The third cut is then made across the vat with the vertical knife. When ordering a new vat, the pair of knives can be made to fit the vat exactly.



Special Large Curd Knives to fit the Vat.

(258) Stirring Curd After Cutting. Very soon after cutting, test the whey for acidity. If the cubes are left quiet too long in

contact with each other after cutting, they will begin to stick together again, forming lumps of larger size, and when stirred later these lumps will break up into irregular pieces of all shapes and sizes. It is necessary therefore to stir the vat enough, beginning very soon after cutting, to retain the curd in cubes of uniform shape and size. The stirring may be begun with a slow motion agitator, or rake, or with the maker's washed arms and hands, reaching down through the curd to the bottom of the vat, fingers together, starting at one end of the vat, in long strokes across the width of the vat, moving slowly toward the other end. The object at first is to move each cube slightly away from its neighbors, so that they will not stick together. This stirring should be continued steadily as long as necessary, but at the same time it must be done gently, not violently, to avoid mashing the curd cubes, and to prevent a high loss of fat in the whey. Most of the fat loss occurs during the cutting and early stirring.

During the first 15 minutes of stirring, before heating begins, the curd should be loosened from the tin surface of the vat at all points, especially at the bottom, corners, and upper edges of the milk, to prevent the curd from sticking fast and being overheated, after heating begins. Allow no lumps to form.

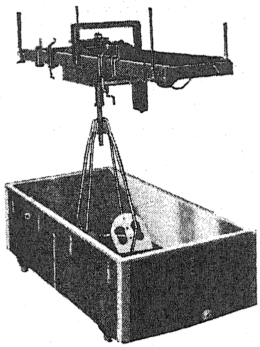
Some makers start the agitator immediately after cutting with a slow speed (6 or 8 R. P. M.) at first, and use a higher speed (10—12 R. P. M.) during and after heating (229).

The cleanly cheesemaker will not forget to dip a rake or other utensils in scalding water just before putting it into the milk, and to wash his hands and arms before using them for stirring.

(259) Heating Up the Vat. After the curd has shrunk and settled somewhat below the level of the whey (which may take 15-20 minutes if slow working, or 10-15 minutes if fast working), the heating is begun, raising the temperature no faster than one degree in two minutes, until the desired temperature, usually 100-102, is reached. Just before heating empty the gate.

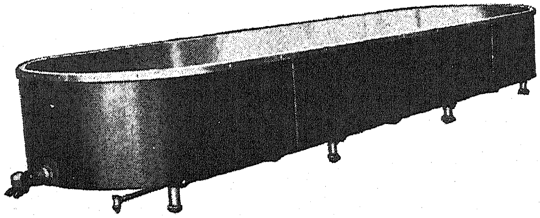
The stirring must continue without stopping during the heating, to prevent part of the curd from remaining on the vat bottom, and being heated too highly. Heating a vat extra high to melt floating fat is useless.

After the vat is heated up the stirring must be continued to keep the curd cubes from uniting to form lumps. After the curd becomes firmer, it is not so likely to become lumpy, and stirring may be stopped for a few minutes at a time, if desired. To stir a large vat of curd with a rake, or two rakes, to keep it free from lumps, requires considerable strength and skill. Where the agitator is used, it may be run continuously until



Modern Agitator with Two Traveling Paddles.

the whey is drawn, watching the corners of the vat at intervals to see that curd does not collect there in lumps. Round end vats have no corners.



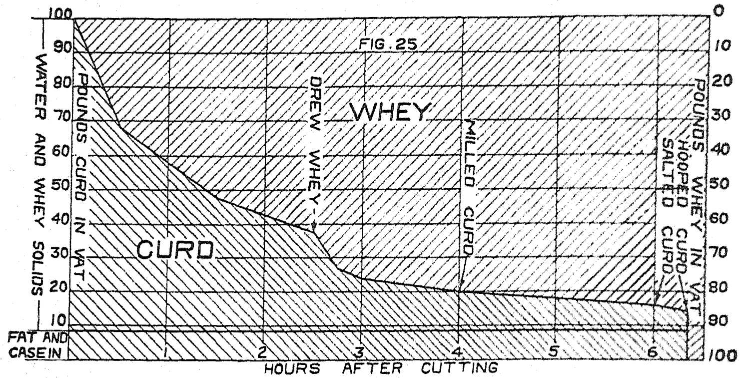
Round End Vat.

(260) Uniformity in a Vat of Curd. The cheesemaker's aim should be to keep all parts of the curd in the vat in uniform condition in all respects, so far as possible, that is, to keep the cubes of uniform size, avoid irregular cutting, or the production of very small or very large sized curd pieces or lumps, also to keep the temperature uniform in all parts of the vat. If the closed steam valve leaks slightly, a little steam entering the jacket will heat some parts of the milk or curd hotter than desired, which should be avoided.

If the steam pipe, between the valve and the vat, contains a short length of steam hose, and the hose coupling, or a tee and valve, or a lever union by which the connection with the vat can be quickly broken without trouble, all danger from steam leaking into the jacket is avoided.

(261) Conditions Affecting the Separation of Whey from Curd. This is a most important subject and should be fully

understood by makers of any kind of cheese.* In milk containing 87% of moisture and 2½% of casein, there are about 35 lbs. of water to 1 lb. of casein. In whole milk American cheese of average composition, there are about 1½ to 1¾ lbs. of moisture



per pound of casein. The per cent of moisture decreases from 87 to 37% during the process, in the vat.

The separation of whey from the curd, by which the moisture content of the curd is reduced, begins at the time the curd is cut and goes on very rapidly at first, but more slowly as time passes. For example, in one case, 100 lbs. of curd lost 32 lbs. of whey during the first half hour after cutting, 20 pounds during the next hour, and 10 lbs. during the next hour, before the curd was matted.

Immediately after the whey was drawn from the vat and the curd piled to mat, the curd gave up whey again more rapidly, losing 10 lbs. in 15 minutes, 3 lbs. the next 15 minutes, and 4 lbs. during the next hour, before the curd was milled.

The curd after milling continued to lose whey slowly, the amount being about 2% in 2 hours, before salting (275).

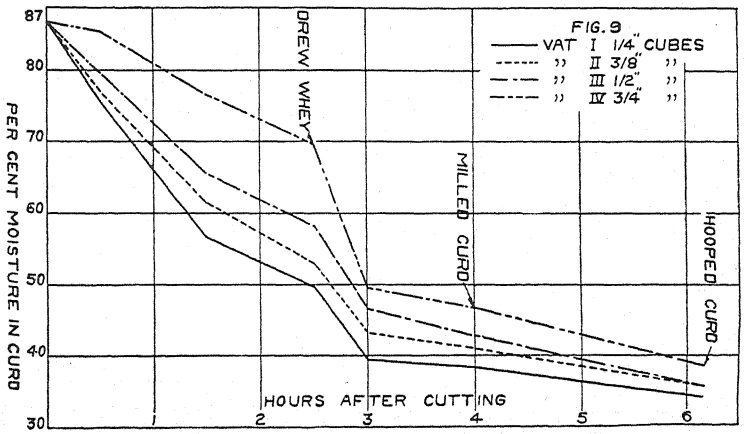
After salting, the separation of curd from whey was again hastened slightly by the action of the salt, and of course there were further small losses in pressing and curing.

(262) Proportion of Rennet Used. It is well known that milk thickens more quickly when a large proportion of rennet extract is used, but after the milk has thickened and the curd is cut, the curd gives up moisture at the same rate whether more or less rennet was added to the milk. (252)

* Wis. Research Bul. 7, J. L. Sammis, S. K. Suzuki and F. W. Laabs. Also Bul. 122, Bur. An. Ind., U. S. Dept. of Agric.

When milk is overripe, the high acidity (with the usual amount of rennet) will cause rapid coagulation, so that the curd can be cut without loss of time.

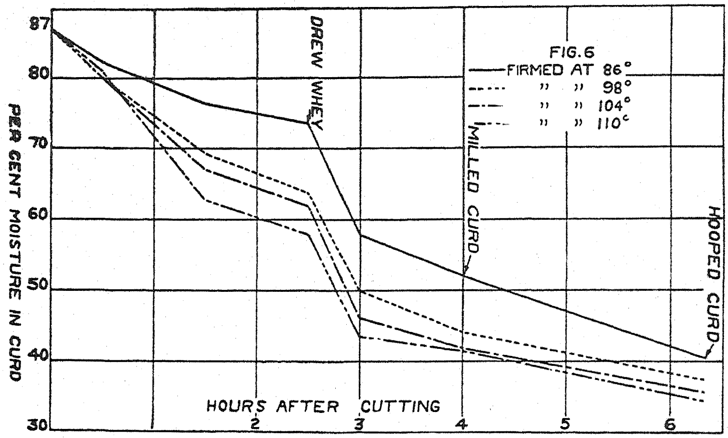
(263) Size of Curd Cubes. The smaller the cubes or pieces into which the curd is cut, the faster the whey will separate after cutting. For example, four vats of the same lot of milk were thickened alike with rennet, but cut with different knives into cubes ¼, ⅜, ½ and ¾ inch, respectively, on the edge. The four vats were handled alike, and in 2½ hours the curds contained 49%, 53%, 58%, and 70% of moisture. These differences in moisture content were due only to the different sizes of the cubes in the four vats.



(264) Effect of Temperature on Separation of Whey. A curd set at 86 degrees and kept at 86 after cutting contained 73% of moisture 2½ hours after cutting, but another vat of curd from the same lot of milk, heated to 104 degrees after cutting, contained only 64% of moisture 2½ hours after cutting. The heating of the vat, properly done after cutting, helps to expel moisture and make the curd firm.

(264A) Uniformity in a Cube. If all parts of a vat of curd are uniform in composition, in size of cubes, acidity, temperature, etc. (260), then a cube of curd at the moment of cutting is uniform throughout, in moisture content. Immediately after cutting, moisture comes out of the surface of the cube in the form of whey, and also moisture moves from the centre of the cube toward the surface. If these two go on equally fast, the moisture content of the cube, from centre to surface remains about uniform, as should be the aim, when the work is done right.

But if the surface loses moisture faster than the moisture at the centre can travel to the surface, then the surface becomes drier than the inside of the cube. The cube begins to resemble a grape with a tough, dry skin on the surface and a soft, wet



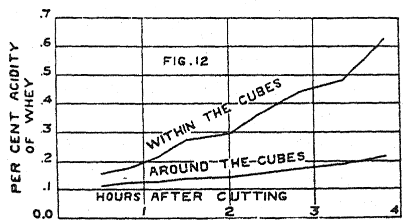
interior. The surface skin then prevents the inside moisture from escaping, and it is hard to get the inside of such a cube firm or dry as it should be.

Often, while the curd is in the whey, the maker should pick up a cube and tear it in two and look to see if it is uniform in firmness from centre to surface, or if the surface is drier than the inside. A dry skin on a curd cube is caused by too high a temperature right after cutting, either by setting the vat at too high a temperature, or by starting to heat too soon after cutting, or by heating too fast. Usually a safe method is to set at 86 degrees, to start heating about 15 minutes after cutting, and to heat no faster than one degree in two minutes.

Neglecting these precautions, a maker heated too early and too fast. The curd surfaces felt firm to the hand in the whey, but after drawing the whey and matting ten minutes, the pile of matted curd suddenly became very soft and spread out on the vat bottom like a pan-cake, because of the high moisture content of the interior of each cube. Such a curd leaked a lot of white whey after milling, and made a high moisture cheese (275).

(265) Acid Developed Inside of Curd. When milk is curdled with rennet, the curd retains most of the fat globules, the bacteria, and any other suspended material. 99% of the bacteria in milk remain in the curd. Acid develops mainly inside the curd, and the whey gains acidity mostly by movement

of acid from the curd into the whey. To demonstrate this fact, fill a bottle or bucket with clear whey (containing no curd) soon after cutting, and hang it in the vat so as to keep it at the vat temperature. Acid tests show that the acidity rises in the vat of curd and whey but not in the bottle containing no curd. If the curd took up acid mainly from the whey, curds would not gain in acid as fast as they do after the whey is drawn. The figure shows the more rapid increase of acidity inside the curd.



(265A) Effect of Acidity on Rate of Whey Separation. In general, the separation of whey from curd goes on faster if there is a moderate amount of acid in the milk and curd, than if they are perfectly sweet. This fact is made use of in cheesemaking. If a cheesemaker wishes to retain more moisture than usual in American cheese, he can do so by setting the milk somewhat sweeter than usual, with less ripening, and with less starter or no starter.

As whey acidity goes up to .17 in the American cheese vat, the curd will give up whey faster and become firm faster for this reason, thus helping the maker to get his curd firm before the acidity has become too high. The cheesemaker may be obliged also to use some other special means (271) of hastening the separation of whey, such as cutting the curd finer, heating it higher, stirring it on the vat bottom after drawing whey, before matting, rinsing, etc., to avoid sour cheese.

The effect of acidity in hastening whey separation from curd is seen in making all other kinds of cheese also, as for example, in making Neufchatel cheese, where with unripened milk it is a long and tedious process to get the curd sufficiently dry, but with ripened milk, handled alike in all other respects, the curd drains rapidly and freely and is finally pressed dry in a half an hour or less. Many other examples and proofs could be cited to show the importance of proper ripeness or acidity of milk as a factor in hastening separation of whey. When acidity of whey goes above .20%, the curd tends to give up whey more slowly.

(266) Effect of Stirring a Curd in the Whey on Moisture Content. The purpose of stirring a curd in the whey was stated

in Section 258. A curd which is not stirred enough soon becomes lumpy and the lumps retain more moisture than the small cubes. A curd which is stirred too roughly is apt to be broken into small pieces or fine grains, and in so far as this occurs, it must be expected that the small pieces give up moisture and also lose fat faster than the regular sized cubes.

If a curd is properly stirred, so as to permit neither the formation of curd lumps, nor of small broken particles, the curd gives up moisture at the normal rate. When the curd is stirred just right so that danger of becoming lumpy or broken is avoided, the moisture content is not reduced more rapidly by either (a) continued stirring as with an agitator, or (b) intermittent stirring done with a rake or by hand. While it seems possible that there might be some difference in the moisture content of curds, due to the method of stirring, as by hand, by a rake, or by an agitator, yet a number of carefully conducted experiments and moisture tests at Wisconsin showed no noticeable difference.

(267) Effect of Pressure on Separation of Whey from Curd. When 500 lbs. of curd is piled 5 inches deep on the bottom of the vat, after drawing the whey, the layer of curd at the bottom of the pile is under a pressure of 500 lbs. due to the curd above it. This pressure greatly hastens the separation of whey from curd cubes for a short time, before the curd mats.

As long as the whey in the vat surrounds the curd cubes, the whey buoys up the curd, so that it presses very lightly on the bottom of the vat when it settles. A cube of curd which weighs 1 gram in air, weighs only about 1/43 of a gram when surrounded by whey. If the 500 lbs. of curd in the vat is allowed to settle to the bottom, before the whey is drawn, it exerts a pressure of about 1/43 of 500 lbs., or 10 to 12 lbs. on the bottom of the vat. As soon as the whey is out, the lifting effect of the whey is lost, and the curd in the air now exerts its full pressure of 500 lbs. on the vat bottom, and on the lowest layer of curd. Drawing the whey is thus one way to apply a certain amount of pressure, which greatly aids in expelling moisture from the curd cubes before they mat. Thus, average curds may lose 3 or 4% of moisture in the half hour just before drawing whey, but 10% during a few minutes after the whey is drawn.

(268) Effect of Stirring a Curd in the Air Before Matting. A curd gives up very little or no whey while in a large mass before cutting, but gives up whey very rapidly after cutting. It is easy to understand that curd in small cubes on the vat bottom, after drawing whey and just before matting, gives up moisture more readily than it does when in a single large mass just after matting. The stirring of the curd to prevent matting has the

effect of keeping the curd in the form of small cubes a few minutes longer, and in this manner permits more complete separation of moisture, producing a drier curd and cheese. Stirring the curd cubes to delay matting, after drawing the whey, is an effective means of rapidly firming any curd, which is too moist when the whey is drawn. The curd forker, rake, and all hands may be needed in this stirring.

(269) Proportion of Fat in Milk. Careful experiments at the Wisconsin Station, not published, have shown clearly that with two vats of whole milk, containing different percentages of fat, as from Jersey and Holstein cows, and handled exactly alike in making cheese, the ratio of moisture to casein is the same, and independent of the fat content of milk. Other experiments in which whole milk and part skim milk were compared appeared to indicate that the casein in skim milk curd gives up moisture more readily than the whole milk curd. (172A)

As fat is not soluble in water, it is clear that the water in cheese is carried by the casein, and the casein, more than the fat in normal milk, affects the rate of separation of whey from curd and the final moisture content of the cheese.

(270) Watching the Development of Firmness and of Acid in Curd. Two important changes go on in the curd, after cutting, both of which should be watched closely by the cheesemaker. These are (1) the separation of whey from the curd by which the curd becomes dryer and firmer as time passes. To regulate the moisture content is the maker's job, and (2) the development of acid by the bacteria in the curd shown by the hot iron test on the curd, and by the acidimeter applied to the whey immediately after cutting and again at intervals.

(a) Under the best conditions these two, **acid** and **firmness,** develop in the curd at the same time, and the cheesemaker tries to have them do so, in order that at the time the whey is drawn, the curd may have both the right acidity and the right firmness.

(b) If the milk is overripe when received, or is ripened too long before adding rennet, or if too much starter is added, the acidity may develop faster than the firmness, and when the acidity is at .17% the curd will yet be softer than is desirable at the time of drawing whey. The whey should be drawn at .17 and the curd firmed rapidly by hand stirring. (268)

(c) If the milk is sweeter than usual, or too little starter is used, the curd may become firm before it shows as much as .17% acid, or as is expected by the maker. In this case, the whey should be drawn when firm enough and the curd matted even if

the acidity is low, and kept warm in the vat for several hours. in order to develop the proper acidity before milling and salting. It is much better to have too little than too much acid, when drawing whey, as more acid will always be developed while matting. Too much acid before drawing whey spoils a great deal of cheese.

(271) Special Methods for Rapidly Firming Curd from Overripe Milk. When it is known in advance that the milk is riper than usual, the process may be varied in one or more of the following ways, to avoid an acid or sour cheese:

(1) Use little or no starter.

(2) Set the vat as soon as possible.

(3) Set the vat to cut in a short time, 20 to 30 minutes.

(4) Cut the curd finer than usual, either by using finer knives, or by lapping the cuts, or by cutting the whole vat of curd once or twice over, in addition to the usual 3 cuts. The extra cutting is usually done lengthwise of the vat with the perpendicular knife.

(5) Begin heating soon after cutting (and perhaps) heat a few degrees higher than usual. At the time of drawing the whey, the firmness of the curd may be increased more or less by treatment as follows:

(6) As the last inch of whey runs out, stir the curd with the hands on the bottom of the vat, one, two, three, or more times over before allowing it to mat. The curd gets firm rapidly, and should be watched closely, and not stirred too long.

(7) If it is quite soft, so that it is difficult to keep it from matting by hand, stir with a wooden rake, teeth downward, while the last of the whey is running out, but shut the gate while there is yet an inch or two of whey on the bottom of the vat. Continue stirring with the rake, as long as desired, until the curd appears firm enough, which will take only a few minutes. The whey left in the vat aids in keeping the curd from matting by reducing the pressure. When firm enough, the curd is drained fully by opening the gate again, and is piled as usual to mat.

(8) An overripe curd is often rinsed (leaving the gate open) with water of the same temperature immediately after drawing whey and before the curd mats. This removes the whey from between the curd cubes, carrying out some lactic acid, and milk sugar which would otherwise go into the cheese. Using four or more pails of water to rinse a large vat of curd will slightly reduce its acidity, and check a slight tendency toward an acid cheese.

Many factory men make it a practice always to rinse every vat of curd in this manner, believing that they thus improve the flavor, and they do this daily, whether the milk is overripe or not.

(9) This method of using water is sometimes carried further with overripe milk by drawing out part of the whey from the vat, as soon as the acidity of the whey reaches the selected point and immediately running water at the same temperature into the vat to dilute the remaining whey. The curd may thus be "firmed in water" for the purpose of avoiding a sour cheese. The difficulty with this method is that few factories have at hand a sufficient quantity of clean water (1,000—2,000 lbs.) at the right temperature for the purpose.

Curds thus rinsed or firmed or washed in warm water should not be confused with "soaked curds" described in section 234, where the purpose and effect of using cold water is to cause the curd to soak up water which it would not otherwise hold.

(10) To handle milk of an unusually high acidity as .25 or .35% or even higher, a method recommended is to add 10, 20, or 25% of water to the milk, and set it at a lower temperature than usual, but not below 78 F., with more than the usual amount of rennet extract, cut fine, rinse the curd with warm water after milling. (Hansen's Dairy Bulletin, Oct., 1925, England.)

(11) An extreme example of the use of water is shown in the method devised and recommended by W. D. Saunders of Blacksburg, Virginia, who adds 5% or more of starter to milk, ripens it to .25% or .35%, adds rennet, cuts the curd, and immediately adds enough water to the vat to dilute the whey down to .07 or .1% acidity. After heating to 100 degrees the curd stays in the whey about two hours, until the acidity is up to .18%. (Virginia Sta. Rept. 1928-1931, p. 44.) To permit this addition of water, the vat is only half (or less) full of milk.

(272) Drawing the Whey. After deciding from the firmness and acidity (.13 to .19% as preferred) of the curd that it is time to draw the whey, the maker should see if the vat has cooled off and if so heat it up to the cooking temperature, about 100 degrees, because the curd will mat more rapidly when warm than if cooler.

The curd is given a final stirring to make sure that it is free from lumps and is then allowed to settle for a minute or two. With a wooden rake, or two rakes, or in New York with a board about six inches wide, as long as the width of the bottom of the vat, and bored with a number of ⅜ or ½-inch holes, the curd is pushed away from the gate end of the vat, moving it forward very slowly to prevent the curd cubes from floating over the rake

or board. A space of two feet or more, free from curd, next to the gate is thus obtained. The vat strainer is put inside the vat next to the gate, and another strainer is placed outside the vat to catch any escaping curd. The whey is now drawn off through the gate, or by means of a siphon, if the vat has no gate. Vats with gates are used in Wisconsin.

To allow the last of the whey to drain out rapidly, the gate end of the vat was lowered slowly when the whey is nearly all out, but in recent years vats are made having the bottom inclined downward toward the gate end so that the curd drains well without tipping the vat.

As soon as the level of the whey goes below the top of the curd, the final draining is made easier if a ditch is made in the curd down the middle of the vat, by hand or with a rake, beginning at the gate end. If this is not done, a good deal of curd is likely to be carried along by the whey currents, stopping up the strainer and delaying the draining.

When the whey is out or nearly so, any necessary stirring or rinsing of the curd is done immediately, before the curd begins to mat.

The edge of the ditch may be trimmed straight with a large knife and the trimmings spread over the curd in a thin layer.

Stray particles of curd on the sides of the vat or in the strainer are brushed down and spread on the curd pile.

When whey is drawn by a siphon from a gateless vat, the curd with some remaining whey is dipped with a flat-sided curd pail (see (193A) Wisconsin brick or (192A) Limburger cheese) into a curd sink, which is on wheels, permitting it to be wheeled into a warm press room, where the matting, cutting, turning, milling, salting and pressing is completed. Siphons and curd sinks have been generally used in Ontario (229) but not in the States in recent years. The use of the curd sink empties the vat, so that it can be filled again with milk, when necessary.

(273) Matting the Curd. Curd is now commonly matted, without stirring, on the bottom of the vat, in Wisconsin, but in former years on draining racks placed on the vat bottom.

To keep the curd warm while matting, the vat should be covered after making the ditch. Cold drafts blowing directly on the curd may be avoided by closing doors and windows, when necessary, while the curd is uncovered.

If the room is cold, the curd may be kept warm by running a little steam under the cover of the vat. The practice of running steam into the jacket for this purpose is not recommended, as it is likely to overheat the curd in spots.

At any time when it appears to be getting cold, the curd surface may be warmed by pouring on several pails of water at 130—150 degrees, with the gate open.

The curd is left undisturbed to mat for perhaps 5 to 10 minutes, or until the bottom layer next the tin is well matted, so as to check the draining of whey through the mass, so that by pressing down with the hand on the upper curd surface a quantity of whey is pressed out and collects around the hand. The curd is now cut immediately into blocks, perhaps 12 by 18 inches, or smaller across the vat, and turned over without breaking the blocks. The turning is begun at the gate end where there is some vacant space.

These blocks may be left, after the first turning, for 10 or 20 minutes, or until their under surface is seen to be matted as well or better than their upper surface, and then turned over and piled two deep on one side of the vat, for more convenient handling, thereafter. They are repiled every 10 or 15 minutes, turning them over each time, turning the cold outer surfaces to the inside of the pile, and changing the lower blocks to the top of the pile.

If curds appear to be firm and dry, they are piled 4 or more blocks deep. This reduces the exposed surface from which moisture can evaporate, and also puts the curd under more pressure, which causes the firm curd to mat well and close up rapidly. A soft, moist curd on the other hand may be left unpiled or in piles two blocks deep, as it will mat readily without much pressure, and being spread out will allow moisture to evaporate more freely.

During the matting process, it is desirable to keep all parts of the curd at the same temperature, and this is accomplished by turning the blocks of curd over and repiling them every 10-15 minutes, keeping the vat covered, etc.

(274) **Reasons for Matting Curd.** The main reason for matting curd is to stop the firming process, and retain the desired moisture content, while waiting, perhaps several hours, for acid development. When the curd is first matted, its acidity is low, as shown by the hot iron test or acidimeter. During the next few hours the curd is to be kept warm in order to develop more acid, so that it may finally string ½ to 1 inch or more on the hot iron, or test .7 to 1% acidity in the curd drippings, by the acidimeter. The curd is allowed to mat during this period (1) because it would be very difficult to keep it in the granular form for so long a time while yet warm, as a great deal of laborious stirring would be required; (2) curd held so long in granular form would become much drier than intended (231).

The development of acid in the matted curd as described greatly reduces the danger of getting gassy cheese in the hoop, which was common in earlier days when curds were made granular, at low acidity. Even when there appears to be no danger of gas, it is much safer always to mat the curd, and wait for acid before pressing.

In order to get a well closed cheese, it is better to begin closing up the curd cubes by matting 1 or more hours while the curd is yet warm. Although the matted curd must be milled later to permit of salting, yet it is milled into larger pieces than the original cubes, and there is much less chance for leaving mechanical openings in cheese, when these larger pieces, instead of the smaller cubes, are pressed.

All the time that curd is held warm in the vat, it is curing much faster than is possible in the curing room at a lower temperature.

(275) Milling Curd. Before a curd can be considered fit to mill, it should be matted at least well enough so that the original cubes will not shatter apart when going through the mill, so that the milled curd will consist of uniform, large sized pieces, free from fine particles. This uniform condition is desirable because with large and small pieces in the milled curd, the distribution of salt will be uneven, as the small pieces have the greater surface area and take up more salt per pound of curd, and cure slower.

An acid test should also be made before milling, either with the hot iron or the acidimeter, to see that the acid test shows .7 to 1.% acid or the hot iron shows ¾ to 1½ inch strings. After acidity has developed thus, there is usually little danger that gas holes will appear in the press or later.

Before milling, it is well to slice off a corner of the curd with a sharp knife and examine the cut surface for pin holes or gas holes. If gassy, the curd should be held in the vat, sometimes several hours, until later examination shows that the gas holes have stopped increasing in size or number. The gas-forming bacteria make gas when they get ready and usually stop in two or three hours. Thus a curd may be gassy in the whey (a floater) or at any time later, but there is less danger after acid has developed and the curd has cooled in the vat. When gas holes appear in curd, there is nothing that the maker can do to hurry their disappearance, but he must wait, before hooping, until the bacteria stop making gas. Whether a curd is gassy or not, it may be milled early or late after matting, depending mainly on its moisture content. Milling does not prevent or stop gas.

If a curd feels softer than usual when matted, it may be milled as soon as ready to mill (see above) and will then give off moisture faster by draining and evaporation than if it were left in the large blocks. Milled pieces, being smaller, give off moisture more rapidly than matted blocks.

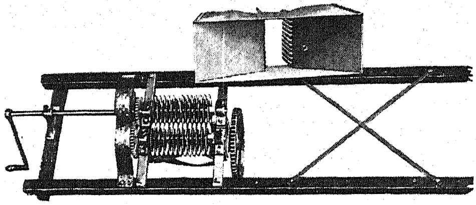
If a curd feels firm enough, when matted, there is no reason to mill it early, but it should be left in the large blocks to develop acid, and milled just before salting. The curd does not get greasy, and rinsing after milling may be unnecessary and a lot of forking is avoided. Milling early would make it drier and firmer than necessary. The regulation of moisture content of cheese is done mostly while the curd is in the whey, but also while the curd is being held several hours to develop acid, by milling early to reduce its moisture, or by milling late to retain moisture.

(276) Styles of Curd Mill. The earliest style of mill consisted of one or two wooden rollers, armed with pegs or spikes, sometimes forked at the end.

Later styles of mill had knife blades for cutting instead of tearing it.

In the Harris mill, and similar kinds, the curd was pushed against a stationary knife or set of knives, the pieces of curd passing between the knives.

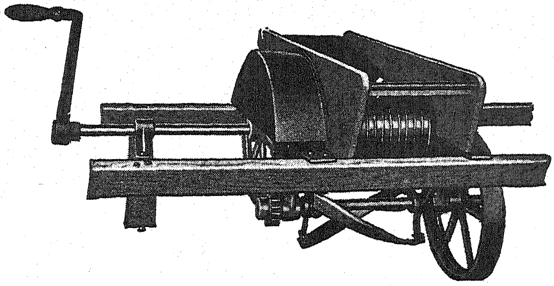
The more modern forms of mill can be run by power, and the curd fed in without stopping. The curd passes first between rollers which carry it forward steadily. Cutting disks of sheet



Modern Curd Mill Operated by Hand or Motor.

metal, spaced about 3/8 to 5/8 inch apart on an axle, cut the blocks of curd into long strips like the fingers of the hand. These strips are next cut off into short pieces like the joints of the fingers, by a set of knives like those in a lawn mower.

(277) Draining the Curd After Milling. After milling, the warm pieces of curd may begin to mat together again very quickly, and to prevent this the curd is stirred.



Modern Curd Mill Operated by Motor or Hand.

The amount and character of the drippings after milling depend largely on the moisture content of the curd. If well firmed and reasonably dry, the drippings are small in quantity and almost water clear in appearance, containing little or no fat. If the curd is moderately well firmed, as in Wisconsin, the quantity of drippings will be larger and its color more or less white and milky, due to a small amount of escaping fat. With a very moist, soft curd, the quantity of drippings after milling may be larger in quantity, and its fat test may be 30%. To save the greatest amount of food in the cheese, the curd should be made reasonably firm in the whey, thus reducing the fat loss after milling. As the curd cools, it will drain less. It may therefore be cooled by rinsing with cool water, if desired, when the drippings appear excessive, in hot weather.

(277A) If the curd becomes quite greasy due to escaping fat, after early milling, it may be rinsed with water at about 90-95 degrees, shortly before salting, to rinse off the fat, which if left on the curd will make it more difficult to close up uniformly when pressed and cause white lines on the cut surface of the cheese, and get the press and hoops greasy.

(278) Salting the Curd. The curd is milled to permit salt to be mixed uniformly through the cheese. Curd may be salted in a short time after milling, as soon as the drippings or rinsings have about stopped running.

The purpose of salting curd is (1) to improve the flavor. (2) It acts as a preservative, covering the curd surface with brine, checking the growth of molds on the surface, etc. (3) The curing process is made slower by the presence of salt so that the cheese is longer lived, and remains in a condition fit for food for a longer time. (4) A small amount of moisture is extracted from the curd by salt.

The proportion of salt weighed out is about $2\frac{1}{4}$-$2\frac{1}{2}$ lbs. to 100 lbs. of curd. After stirring the salt all through the curd the

presence of the salt grains gives the mixture a rough, harsh feeling in the hand. After a few minutes the salt dissolves in moisture extracted from the surface of the curd pieces. This leaves the curd surface somewhat drier and rougher feeling than before salting.

The curd is stirred up every 10 minutes after salting, and spread out to cool, usually with the vat uncovered. Some of the salt brine runs off of the curd, and in this way from ½ to ⅔ of the salt added may be lost. The escaping brine should be caught in a pail and poured over the curd again.* Slowly, the brine begins to soak into the curd. The longer the curd is left in the vat after salting, the more salt is retained inside the cheese. If curd is pressed in 15-20 minutes after salting, most of brine is on the curd surface, and is squeezed out by the pressure. But when the salted curd is kept wet with brine for an hour in the vat, more of the salt brine soaks in and less of it is squeezed out in the press. The flavor is improved.

For best results in closing curd in the hoop, it is left in the vat with frequent stirring until the curd again feels mellow and silky to the hand. It is then filled into the hoops with a scoop, usually weighing the curd into each hoop to secure uniformity in size of cheese. About 12 hours are required for salt to become evenly distributed inside of milled pieces of curd (Journal of Dairy Research (1936)-156). Never rinse curd after salting.

(278A) Saltpetre in Cheese. Before the passage of laws forbidding the addition of foreign substances (with certain exceptions) to milk or curd for cheese, the addition of small amounts of saltpetre was practised by certain makers, in the hope of preventing bad flavors as gas holes in cheese. Various "minerals," or mixtures containing salt and 5% or more of saltpetre have been advertised and sold for cheesemakers' use.

Large red blotches seen on the cut surface of cheese made with saltpetre have led to the enactment of regulations specifically prohibiting the use of saltpetre in cheese. (Canada Dept. of Agric. bul. 128) (Wis. Statutes 97.38)

Numerous makers have abandoned the use of such minerals." after trial, as being an unnecessary expense, without benefit to cheese quality, as well as unlawful.

(278B) Sugar Added to Curd. The addition of ¾% of sugar to milled curd is said to reduce the moisture content slightly and improve the cheese quality. Amer. Cry and Poultry Jrnl., vol. 83, p. 28, (1897). Salt is cheaper than sugar.

(279) Styles of Cheese Hoops. The simplest form of hoop is a plain cylinder of wood or metal open at both ends, which

* 1938 Ann. Rept. Wis. C. M. Assn.; Nat. B. and C. Jour., Sept. 25, 1938.

was widely used with the old fashioned vertical press. A wooden follower, inside the upper end of the hoop, rests on the curd. In the early days, the hoops were removed after pressing the cheese, and a cloth bandage was wound around and fastened to the cheese.

Instead of being cylindrical, hoops are now made a little larger at the top to permit easier removal of the cheese. Hoops are also made with closed bottoms in most cases, though sometimes these are loose and can be removed. The bandages are now applied to the hoop before filling it with curd, requiring less work than to bandage the cheese after pressing.

The Canadian Cheddar cheese hoops are provided with a large tin funnel, fitting closely inside, and carrying the bandage, which is cut of the right length from a bolt of the tubular cotton cloth. In filling this hoop, the curd is placed and pounded down with a wooden packer, shaped like a bowling pin, or a baseball bat, and weighing about 5 lbs. After filling the hoop with curd, the bandager funnel is lifted out, leaving the bandage in place on the cheese. Large square cap cloths are used.

In the United States, where smaller cheese are more commonly made, much time is saved by bandaging the hoops earlier in the day, before they are needed, since many are used. The Wilson hoop was widely used in the eastern states, and the Fraser hoop elsewhere.

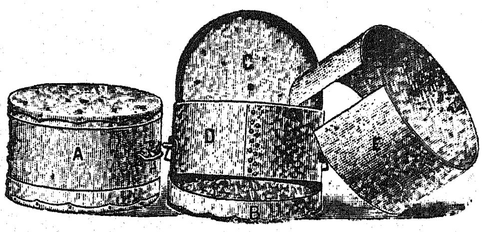
(280) Directions for Using the Wilson Hoops. Each hoop consists of four pieces, as follows:

B. The bottom cover, with the widest flange or rim.

E. The open wide hoop.

D. The closed or tight wide hoop.

C. The top cover with narrow flange or rim.



Wilson Hoops are used in the eastern states.

First—Place the cover with the widest rim (B) on the ways in the bottom of the press.

Second—Place the cap cloth on the bottom of the cover (B). It should be as large as the bottom of the cover.

Third—Place within the bottom of cover (B) the open hoop or bandager (E).

Fourth—Wet one edge of the bandage, adjust with the open hoop and turn the wet edge over the top of the hoop.

Fifth—Put the closed wide hoop (D) on top of the open one, letting it lap over about one inch, and fasten the hooks which are provided to keep it from slipping down.

Sixth—Put in the cheese curd as may be desired, for any thickness the cheese are to be made, but always put in enough so that the outer or tight hoop in pressing shall not quite be forced down far enough to meet the edge of the lower cover.

Seventh—Put on the top cover (C), then unfasten the hooks under the handles, then turn the cheese over, placing the top cover up snug against the head of the press. Proceed in the same manner until all hoops are filled, placing the top cover against the bottom of the previous one.

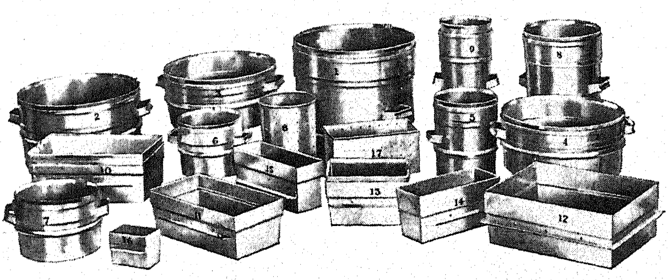
Eighth—After pressing as usual for about an hour, the bandage is turned in or lapped over the edge of the cheese in order to press the bandage down. It is well also to remove the cheese from the hoop, turn it over, and put it back in the hoop with the other face up, and then put to press again. This will give opportunity to remove any wrinkles that may have formed in the bandage.

(281) Sizes of Hoops and Cheese. Supply houses list many different sizes of cheese hoops, either in Fraser or Wilson style, but only a few sizes are in common use.

The usual market sizes of whole milk American cheese in various states are about as follows:

Name	Weight, lbs.	Diameter, inches	Height, inches
Young America	10-12	7	7 8
Long Horn	12-13	6	11½-13¼
Daisy	20-22	13½	3½-4¼
Flat	32-37	14½	5½-6
Cheddar	70-78	14½	10½-12

Square prints weigh 2½, 5, or 10 pounds each.



Sizes and styles of metal hoops for American, brick, and Muenster cheese, etc.

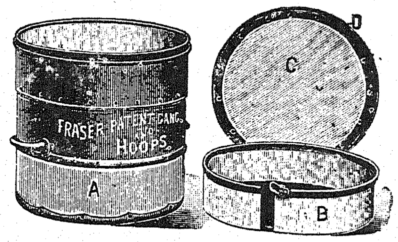
Canadian cheddars usually weigh about 85 pounds and are sometimes cut in two, making flats or twins. The Canadian stilton shape is about the same as the Young America. Prints or daisies may have marks impressed on the rind to show where they may be cut into 1-pound slices.

(282) Cutting Cheese in Two. When this is necessary, as sometimes with cheddars, it is done the next morning, after taking the cheese from the press. By means of a pair of dividers, or a pencil put through one end of a stick a mark is made around the cheese exactly at the middle and a sharp knife is then used to cut through the bandage along this line. A piece of copper or steel wire, with short sticks at each end for handles is wrapped around the cut, and drawn up tight, thus cutting the cheese smoothly in two. Each cut end is then covered with a cap cloth, and both halves are returned to the press for a few hours, to close and smooth the cut ends by pressing.

(283) The Fraser Hoop and Its Use. The hoops are cleaned and made ready for use during the day. The cap cloth of muslin or, better, of canvas, is placed in the bottom of the hoop. Sometimes on top of the cap cloth there is placed also a starched circle of bleached cloth and starched cheese cloth.

The bandage, if woven tubular, is cut the right length from a bolt and is applied to the bandager, (B), which is the loose, upper split ring belonging to the Fraser hoop. If the bandages used are "ready made," that is, cut from cheese cloth and sewed up by machine, the bandage must first be turned inside out, to get the "wings" inside; and the wide end, if the bandage is tapered, is then applied to the bandager.

Pushing the bandager down into the hoop until it fits against the shoulder, the bottom of the bandage should be long enough to turn about three-quarters of an inch on the bottom of the



Modern Fraser hoops have metal followers.

hoop. The hoop is now ready to receive curd, which should be weighed in, to get all the cheese of uniform size, and is packed down tightly by hand.

Another cloth or pair of cloths is put on top of the curd, the same as at the bottom of the hoop, the follower is added and the hoops are piled up two or three deep, until all are ready for the press.

After pressing for about an hour, the cheese in the Fraser hoops require to be dressed. To do this, the hoop is taken from the press, and the follower is taken out with the hook. The bandager is then removed, releasing the upper end of the bandage. The hoop is then turned upside down, dropping the cheese on the table, or on a plank laid on top of the press. The cap cloths are removed, all wrinkles are pulled out of the bandage and the end of the bandage turned under the cap cloth. If high edges occur, due to loosely fitting followers, these are corrected and the cheese are returned to the press. If the cheese are crooked, that is, higher on one side than on the other, this is corrected by turning all such high sides to the bottom of the press. The cheese are then put under pressure and left until next morning. The press should be tightened either automatically or by hand, so as to keep the cheese under full pressure throughout the night.

The Fraser hoops are made slightly wider at the top than at the bottom, so that they nest together in the press.

When dressing the cheese, if it is seen that the top of the cheese stands above the shoulder of the hoop, the bandager should be put back in the hoop, to avoid a mark on the cheese due to the shoulder. The old style wooden follower with a fibre ring edge has now been replaced by metal followers in Wisconsin.

(284) Weighing Curd into Hoops. In order to have cheese of uniform size, it is customary to place scale in or over vat, and weigh the curd for each hoop, in the hoop or in a pail. Especially when metal followers are used, without flexible fibre rings, it is necessary to place the correct weight of curd in each hoop which it is made to hold, in order that the follower may fit just right in pressing.

(285) Pressing the Cheese. It is best to apply a light pressure at first, just sufficient to start the drippings and to increase the pressure as fast as necessary to keep them running, until the full pressure is on.

After dressing the cheese in the hoops, the pressure should be maintained during the night, either tightening up the press by hand, when the cheesemaker goes to bed, or making use of an automatic pressure device.

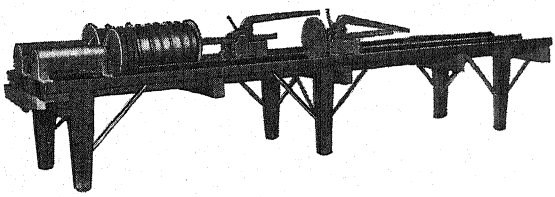
The aims are to close up the interior of the cheese into a solid mass, with as few mechanical holes left as possible, to close

up the rind perfectly leaving no openings through which air may enter and permit the growth of molds inside of the cheese, to give the cheese a workmanlike appearance, in size and shape, with a smooth and tightly adhering bandage.

The warmer a curd is when pressed, the fewer will be the mechanical holes in the cheese. Hot water may be poured over the hoops during the pressing, to close the rind perfectly. But no hot water should be poured on curd in a hoop, as this washes out salt.

(286) Sampling Cheese for Moisture Test After Pressing One Hour. If cheese are thoroughly pressed for one hour before dressing, moisture test samples may be taken while dressing the cheese, and the moisture tests thus obtained will agree closely with those obtained from samples taken next day. For this purpose the bandage may be turned down somewhat from the side of the cheese, and the trier inserted in the side, placing the trier plugs in sample bottles (75). During the night pressing, the trier holes will close up entirely.

(287) Cheese Presses and Continuous Devices. The primitive forms of cheese press working by means of a weight or weighted lever (240) were first replaced in American cheese

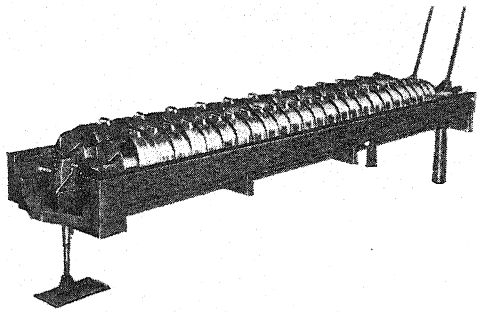


A modern style of cheese press. Several sizes of cheese can be pressed at once. The pressure is automatically maintained over night.
Modern Automatic Cheese Press.

factories by vertical screw presses, which are yet used in a few factories. In recent years, horizontal gang presses have come into more general use, by which a long row of cheese are pressed by means of one screw, or by a hand lever.

It is possible for remote factories to purchase the iron screw, nut and lever, and build a press from this by adding wooden rails or timbers. The same press can be bought already made with steel rails.

Several devices have been contrived for automatically taking up shrinkage and keeping the cheese under pressure throughout the night. The simplest of these consisted of a set of one to four coil springs, enclosed in an iron box, which was put in the



Built in several styles, with continuous pressure.
Modern Automatic Cheese Press.

press along with the cheese. The springs were closed by the pressure applied at first, but later they expanded as the cheese shrunk. The Sprague device consists of a weight on a long lever arm, which in moving downward opens a toggle joint, and offsets the cheese shrinkage. These have now been largely replaced by presses in which a part of the press moves downward under the weight of the cheese, tightening up the head block in so doing. The new hydraulic press is now widely used.

(288) Taking Cheese from Hoops. After building a fire under the boiler, the maker's first work in the morning is to take the cheese out of the press to get the hoops ready for use again. The follower is removed by means of a hook, and the cheese is loosened from the sides of the hoop by running the flexible blade of a steel spatula or table knife all around the inside of the hoop. The hoop is turned over, and tapped lightly on the table, and the cheese falls out. It should be quickly inspected and if satisfactory in appearance, is placed on the curing room shelves. If faults in workmanship are seen, these are corrected so far as possible, and the cheese thus treated may be returned to the press and left until noon, when they are placed on the shelf. Each cheese on the shelf should be stamped to show when and in which vat it was made, and the factory number if required by law.

(289) Faults Seen in Green Cheese. If some of the cheese, when taken from the press, are crooked, that is higher on one side than on the other, they should be returned to the hoop and the press, with all the high sides at the bottom of the press so that after repressing, this fault will be corrected.

If bandages are wrinkled, they should be loosened from the cheese surface, and pulled smooth, and pressed again to make the bandage stick to the cheese as it should. If the bandage

was not placed correctly in the hoop at first, it may lap too far or not far enough over one end of the cheese. This may be corrected by loosening the entire bandage, and moving it into place, or if too long, by cutting off part of the bandage and repressing.

If the rind is not well closed, showing too light pressure or too large a follower, or that the curd was too cold when pressed, hot water may be poured over the outside of the hoop, in the press, and the follower may be trimmed, dipped in hot water, and the cheese repressed.

Faults due to careless workmanship mark the maker as inattentive, and cheese buyers as well as factory patrons soon learn which makers can be depended on always to make a neat appearing product. Too much acid causes cheese to close poorly, and the cap cloth when pulled off may tear away some of the rind.

A new cloth or a freshly washed cloth is more likely to stick to the cheese surface in pressing than an old cloth containing more or less grease. New dry cloths, dipped in hot paraffine, and wrung out hot by hand or through a clothes wringer show much less tendency to stick to cheese surfaces, or to tear the surface when removed.

(290) Cheese on the Curing Room Shelves. In many American factories cheese are kept only a few days on the shelves before shipment to the buyer's warehouse. The Wisconsin Marketing Department requires that cheese be held at least three days on the factory shelf before shipment, and marked with a rubber stamp showing the date of manufacture, date of packing or paraffining and factory number. On the shelf, they should be turned daily in order that both ends of the cheese may dry evenly, and not become moldy or checked. The cheese should be well dried on the surface when boxed and shipped, so that they are not moldy but fit to be paraffined when received at the warehouse. A few factories paraffine cheese before shipment. The curing room should be sufficiently dry so that the cheese do not become moldy. The shrinkage in weight during this period before paraffining may be about 5%, but somewhat lower if the room is damp. Moldy cheese may be cleaned with a dry brush, by scraping, washing and drying, or by applying a clean bandage and pressing (134).

(290A) Late Gas in Cheese. When cheese, after several days on the shelf, develops large gas holes, or "sweet holes," these may be due to spore-forming bacteria in the milk or starter. 25A, 33, 18, 193C.

(291) Boxing Cheese for Shipment to Buyer. A piece of thin wood veneer, called "scale board," is placed in the bottom of each box, and another on top of the cheese in the box, and

Cheese Damaged by Nails, etc.

two scale boards between the cheese if two or three cheese are placed in the same box. These scale boards prevent cheese from sticking to each other or to the box.

Heavy press cloths or heavy cap cloths, if used, are taken off of the cheese just before boxing. Thin starched circles, if used, may be left on until the cheese are ready to be dipped in paraffine. If cloths are removed too long before paraffining, the bare cheese rinds are likely to check or crack open, and admit mold to the interior of the cheese.

The boxes, if taller than the cheese, should be cut down so that the cover rests on the cheese as well as on the sides of the box, to prevent the boxes from splitting when piled high.

The box lids should fit snugly, otherwise it may be necessary to wedge each lid on, after filling the box with cheese, to prevent falling off, and because railroads usually will not accept shipments with loose box lids.

The boxes should be stored at the factory so as to keep dry and clean.

Where two or more cheese are put in one box it is possible to make a selection so that all in a box will be of the same size or that the total weight of cheese in the box shall be at the desired figure. Don't drive nails into cheese.

On the outside of each box, at one side of the nailed lap, should be placed the "marked weight" which has been from $\frac{1}{4}$ to $\frac{1}{2}$ pound less than the actual weight of cheese when boxed. This allows for shrinkage and ensures that the buyer should receive the weight of cheese marked on the box and billed to him. The buyer's stamp or stencil is used in marking each box for shipment.

On the other side of the nailed lap should be placed the lot number showing when the cheese was made. This enables the buyer to sort the boxes into piles by vats when received, so that by boring one cheese from each pile, he can test the quality of all.

(292) Shipping Cheese. In packing boxed cheese in a railroad car, they should be piled evenly and arranged so as not to fall down or be broken in transit. Refrigerator cars pass through principal cheese shipping points twice a week or oftener and serve in summer to protect cheese from overheating and from freezing in winter. In very cold weather, cars of cheese may be provided with oil heaters to prevent freezing. Frozen cheese should be slowly thawed at 34-50 degrees, and may or may not show damage.

Cheese are sometimes damaged by being hauled to the station and left standing in the sun for several hours before being placed in the car, or by being kept in the uncooled factory curing room longer than usual in summer, because of failure to receive cheese boxes when needed, or other causes.

Where cheese are to be shipped a long distance, especially to various export markets, the box lids may require to be wedged on tight, or the boxes may be placed in sacks or fastened together in 100-lb. packages with strap iron, to meet the demands of railroads or ship owners.

(293) Cheese at the Receiving Warehouse. The buyer of cheese from a factory receives the shipment in his warehouse, counts the boxes, sorts them in piles according to the marks, tests one cheese from each vat by drawing a trier plug, and starts opening the boxes. At least 5 or 10%, or all of the cheese in a shipment, are weighed on a dial scales, as they come from the boxes to see if the weights billed and marked on the boxes are correct. The cheese are dipped in paraffine and replaced in the boxes and may be either shipped out again immediately to purchasers, or placed in cold storage rooms, carefully arranged in piles, so that the contents of every pile is known exactly and can be given proper attention and finally shipped to a suitable market.

If the cheese buyer finds either the quality or the marked weights of the cheese to be below the standard, the deficiency is noted, and notification is sent to the shipper at the factory, who may then accept the buyer's offer as to weights and reduced price, or may dispose of the cheese in any other way.

Upon the buyer's judgment as to whether a given lot of cheese is of fit quality to be put into storage or not, so as to be taken out several months later without loss of quality and value, depends his profit or loss.

Wisconsin Marketing Department rules have required that cheese must be graded and stamped with the grade by a licensed grader when sold. This grading is usually done at the buyer's warehouse, or sometimes at the factory.

(294) Paraffining Cheese. Cheese to be paraffined should be well dried on the surface and should have a small amount of dried cheese at the surface, forming a rind. The purpose of the paraffine is to protect the rind, prevent the growth of molds and minimize the shrinkage or loss of weight, by checking the evaporation of moisture.

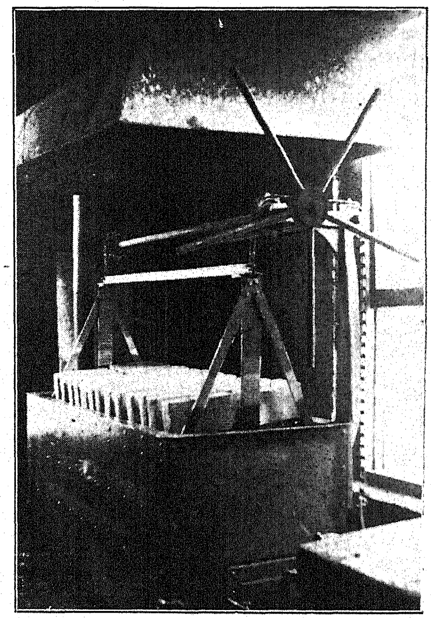
The paraffine melting at 123-125 degrees is heated in a steam tank to about 220 degrees and the cheese are immersed for about two seconds. Under these conditions, the paraffine coating on the cheese is thin and flexible, and is less likely to crack off than if a thicker coating is applied at a lower temperature. The longer the cheese is held in the paraffine tank, the hotter its surface becomes, and the thinner the final coat of paraffine will be. Recently, some new waxes have been offered to be heated to 260, F., with which it is claimed that new cheese, fresh from the press, can be satisfactorily paraffined.

(294A) Loaf Cheese Wrappers. After a number of experiments to disinfect the cheese surface by heat, and to coat it with some protective substance, to prevent the growth of mold on cheese in the package, the use of cellophane, parafilm, from the Menasha Products Co., pliofilm from the Goodyear Tire and Rubber Co., etc., and similar products have met with increasing success. (248).

(295) Rind Rot. Where a thick coating of paraffine is applied to cheese having a poorly dried surface, or too thin a rind due to insufficient drying, it will probably be found after a few days, weeks or months, that the paraffine is not adhering to the surface, but cracks off readily and that underneath the paraffine, the surface of the cheese is wet and smeary. This condition is called "rind rot," and may be so objectionable as to require

that the cheese should be cleaned by washing, drying in the air, and paraffining again before they are sold. This extra trouble and expense is avoided by seeing that cheese are in proper condition before first dipping in paraffine.

(296) Paraffining Equipment. Paraffine can be heated to 220 degrees F. or above in a sheet metal or boiler iron tank by means of coil of steam pipes placed in the bottom of the tank. The entrance and exit pipes for steam should come up over the top edge of the tank, as it is difficult to make a tight joint and avoid leakage of paraffine, if a hole is cut in the side of the tank near the bottom. Through leaky joints, steam pipes may fill, while cooling, with liquid paraffine, which solidifies when cold in the pipes.



A paraffining outfit used in a large Wisconsin warehouse.

With a paraffine tank made of boiler iron with a double wall, steam is admitted to the jacket, direct from the boiler, and the condensed water from the jacket may run back into the boiler by gravity. A small steam trap can be used to allow water but not steam to escape.

In some warehouses, the paraffine tank in use consists of a boiler iron tank, heated by a row of gas jets underneath, and in order to keep the paraffine from becoming too hot and boiling

over and thus taking fire, an automatic temperature regulator may be used, or a small amount of water poured into the tank, making a thin layer below the paraffine. In this way, the paraffine is never heated higher than the boiling point of water, about 212 degrees F.

Where only a few cheese are dipped this can be done with tongs, one at a time, but in large warehouses, dipping frames carrying several hundred pounds of cheese, balanced by a weight on a rope and pulley, are suspended over the hot paraffine and immersed with the least loss of time.

(297) The Cold Curing of Cheese. The supposition that cheese are injured, becoming bitter, etc., by curing in cold storare was overthrown by the experiments of Babcock and Russell at the Wisconsin Experiment Station, beginning about 1895. At present, cold storage warehouses having mechanical refrigeration maintain American cheese rooms at 34 degrees. Other houses cooled by ice hold cheese at 40 to 45 degrees.

In some cases, cheese held two weeks at 37 F., followed by storage at 55 degrees, were of better quality than those held at 55 from the start. (Nat. B. and C. Jrnl., Sept. 1939, p. 34.)

The Canadian cheese warehouses are commonly kept at temperatures above 50 degrees which practice is called "cool curing." Recently, leading factories have used ice or refrigeration machines for cooling the curing room.

In a recent bulletin (1941) from the Division of Research Laboratories, Bureau of Dairy Industry, U. S. D. A., by Wilson, Hall and Johnson, experiments are presented, showing that "if a cheese is destined as a result of some inherent defect in the making process to have a score below 92, it will have a relatively higher score if it is held at 34F. than if it is cured at 50 F.

When cheese is held 6 months at 34 F., the percentage that will score 92 or better will be about the same whether the moisture content is above or below 38%.

When cheese is cured at any of the higher temperatures used in this experiment, however, the percentage scoring 92 or better will be from 5 to 15 per cent in favor of the low moisture cheese.

Cheese made from milk of good quality, and by methods which insure cheese of good quality can be cured at temperatures as high as 50 F., with reasonable certainty of developing a clean and characteristic Cheddar flavor.

Cheese made from bacteriologically poor milk or so manipulated that there is a tendency to develop acid, bitter, or other off-flavors, should be stored at 34 F. in order to retard development of these defects as much as possible."

(298) The Cold Storage of Cheese. Cold storage is used as a means of preserving cheese in good condition from June, September, or October, until the winter and early spring months, when little is made.

Privately owned cold storage warehouses in leading cheese centers rent rooms or space at fixed rates to cheese owners, charging in some cases 1/4 of a cent per pound of cheese for the first month and 1/8 cent for the second month, or a certain maximum price for storage until the following February 1st or March 1st. The cheese owner must recover the expense of the storage, shrinkage, and the interest on his money invested in cheese during the winter, from the increased price at which the cheese may sell in the spring.

In case the cheese placed in storage deteriorates in quality during the winter, the owner is likely to suffer loss, and great skill and care must be used in selecting for storage only well made cheese of good quality and suitably low moisture. Cheese in cold rooms should be examined once a month.

Small white specks seen on the cut surface of well cured cheese have been found to be composed of calcium lactate, and entirely harmless.

CHAPTER XXX.

Italian and Greek Cheese in America

(300) Skim and Whey Cheese. These cheese are mostly made from skimmed or partly skimmed milk, and in some cases from whey. They are heavily salted, and have more or less acid flavor. The cheese are not used by the average American trade, and few dealers handle them. While there is a certain small

Italian Cheese, Hoops, Baskets, and Containers.

demand for them in this country, yet the business is in the hands of a very few firms, and factories should first make sure of a reliable outlet before beginning to make these products. Pasteurized milk is used in some Wisconsin factories. See also Nat. B. & C. Jour., Jan. 1942, p. 10-38.

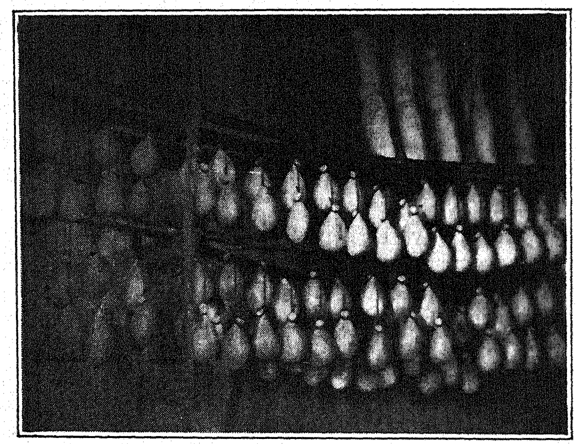
(301) Caccio Cavallo and Provolono. The former, shaped like a bowling pin, and the latter, shaped like an egg or a ball, are usually made from one-third skim milk and whole milk respectively, by practically the same methods except in the final shape given to the cheese.

The curd, made with about 1½% starter and 3½ ounces of rennet extract per thousand, but without color, is cut rather fine, and when firm as for brick cheese, the curd is piled up at the gate end of the vat around the strainer, the vat is tipped, and whey drawn out, leaving only enough in the vat to cover the matting curd. Whey is caught below the gate, heated to 125 degrees F., and put back on the curd in the vat. The temperature is kept at about 125 degrees for 4 to 5 hours in summer, or 8 to 10 hours in winter, until the whey tests nearly .5% acid, and the curd gives the proper test in hot water.

For convenience, a tank of water is kept hot at about 175 degrees F., and a dipper full is used for the test. A piece of curd the size of the little finger is cut from inside the matted curd in the vat, squeezed well in the hand to elongate it, and one end is dipped in the hot water, for a few seconds, and then the other end, by which means the middle section becomes very hot. The piece is twisted and stretched, slowly, with repeated dipping in the hot water, to see if it will stretch out into a fine thread a yard long without any tendency to break, or any lumps or uneven spots in the thread.

When it will do this fairly well, the whey is drawn off, and the curd cut into long strips about 2 inches square on the end, and left to drain for half an hour or so, to remove free moisture, and develop more acid.

A tub, preferably round bottomed, is filled with water at about 130 degrees, or as hot as can be handled. A weighed portion of curd, about 6 or 7 lbs., is dropped in, and stirred with a paddle, squeezing it together until it is all in a plastic mass. It is then lifted out with the paddle, and worked with the hand into a compact mass and put back into the water. When quite plastic, an end is drawn out, and wrapped around the hand, as the stringy curd about 1 inch thick comes out of the water. A handful is laid down, and the next handful packed tightly against it. When all has been worked in this manner, the combined lump of curd is heated again in the hot water, and worked in the hands with frequent heating, working the mass upward in the middle from below, until the entire outside is worked in, and the surface is smooth, the rind perfect, and the end is twisted off.



Pear-shaped Italian Cheese.

The cheese may now be dipped, one at a time, in very hot water, to give better finish, and finally is laid in a cheese cloth tacked across in a vat of cold water or suspended in cold water. After cooling a little, the curd is taken out, and reshaped if necessary, and finally left in the cold water over night. It is then left floating in cold brine, under a board, for 3 or 4 days, then dried and oiled on the surface. The egg shaped cheese is called Provolono. After curing, hung up to the ceiling, they are packed in barrels.

The Caccio Cavallo curd, generally part skimmed, is moulded into the shape of a bowling pin, and then handled similarly, to cool, harden and salt it. If these cheese are lumpy on the surface, it indicates not sufficient acid or too much, either of which causes short texture. Various sizes of pear-shaped cheese are made by the same general methods.

(302) **Romano.** This is usually made from skim milk. The rennet curd made as for brick cheese is packed into molds open at both ends, about 8 inches in diameter and 6 inches high. It is salted on the outside, after draining 24 hours.

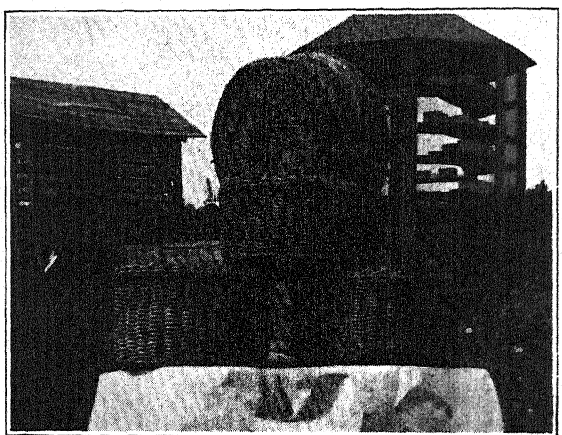
(303) **Romanello.** This is made like Romano, excepting that the curd is placed in a wicker basket to drain, and after draining, the mass of cheese retains the imprint of the woven basket on its surface. The cheese are about 9 inches in diameter and 5 inches high, and weigh 9 to 12 pounds. Baskets of different sizes are used.

(304) **Feta.** The skim milk is thickened with rennet, stirred or cut with knives, and then dipped into large wooden molds about 48 by 30 inches or any convenient size, and 8 inches deep, standing on draining cloth and table. A little later it is cut into large blocks, salted on the surface, and later turned over and salted again. The next morning, the curd is cut into slices about an inch thick, and packed in paraffined wooden kegs, holding about 125 pounds, with some salt. The spaces between the curd pieces are soon filled with salt brine from the curd. The cheese is ready to eat in thirty days.

(305) **Ricotta or Recorta.** This is composed mainly of whey albumen, 14-18%, moisture 68-75%, fat 4-5%, sugar and ash 6-7.5%. The whey used should be so sweet that it will not curdle at 190 degrees. In making, the sweet whey with perhaps 5 to 10% of skim milk or whole milk added, is heated to 182-190 degrees with steam in the jacket. Enough clear vinegar is added (about 1/3 of 1%), or sour whey (.9 or 1% acidity, held 2 days at 100 F.) using about 1 barrel for 8000 lbs. whey. After stirring very gently, the whey is left to stand quiet for 5 or 10 minutes, continuing slow heat. The curd rises and floats, and is

dipped off with a fine meshed strainer, and poured into metal hoops about 9 inches high and 6 inches in diameter, flaring like a lard pail, and with strainer sides and bottom, or with many holes punched from the inside outward. The curd settles over night to about 7 inches height. The cheese may be slipped into a bag or bandage, and pressed in the hoop for a few hours to close it better, and may then be packed in 5 lb. paper cups for sale fresh. If to be cured, the pressed cheese is rolled in salt next morning, and returned to the hoops to drain further, after which the cheese are put to dry in a room at 110 degrees, on shelves, or dried in an open air shed, protected from flies and mice. The dried cheese shrink to 4 inches diameter and height, and weigh about 2 lbs. each.

When whole milk is added, not over 1/3, the cheese is called ricotta gras. The addition of milk makes the fresh cheese have a softer texture, as it contains also casein and fat. Such a cheese 7 inches high and 8 inches diameter is called Maroni, and where no milk is used, it is called Mejette. Jour. Ind. Eng. Chem. (1921) p. 515.



Baskets for Romanello Cheese.
Out Door Drying Sheds for Ricotta.

(306) Parmesan and Reggiano. These are skim milk cheese made in copper kettles somewhat like Swiss cheese, but smaller in size. They are hard, and are grated for cooking.

Asiago. This may be made in a kettle or vat. The rennet curd is cut very fine as for Swiss cheese. If in a vat, the fine cutting is done by final rapid movement of the vertical knife, continued for 10 minutes or more. When firm enough, the whey is

half drawn out, and the curd is scooped into daisy size hoops, lined with a square of heavy coarse mesh cheese cloth. A follower is put in and the curd pressed.

Next morning, the cheese is put on the shelf, rubbed with salt, and enclosed in a small sized Swiss hoop, tightened to fit the cheese. It is turned over and salted daily for three days, and cured in a cool room.

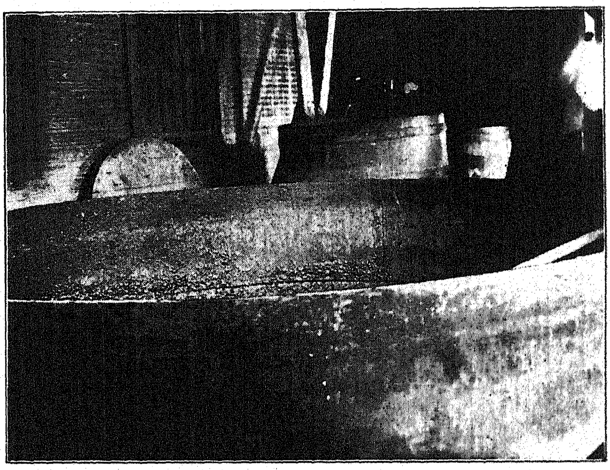
As with other unusual types of cheese, the maker should always be sure to locate a reliable buyer before making any great quantity.

CHAPTER XXXI.

PRIMOST

(307) Manufacture and Use. In Norway and some other countries, whey left from cheesemaking is boiled down, like maple sap, until on cooling it will solidify, like maple sugar, into a crumbly mass consisting mainly of milk sugar. This is good food, but rather lacking in attractive flavor, and is called Primost.

By adding some buttermilk or whole milk to the whey the product is more pasty, and is called Soft Mysost. From sour milk cheese whey, the product is called Sur-prim; and Mysmer from sweet curd whey. Mysost means literally whey cheese.



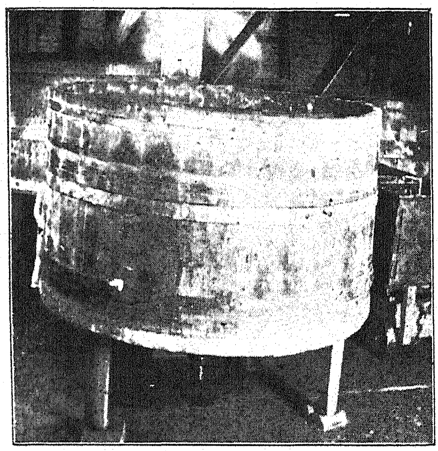
A Primost Pan used in Wisconsin.

To meet the demand in this country from former residents of northern Europe, for this product, a few factories in the northern states, including Wisconsin, Michigan and northern Illinois make Primost.

The whey from the cheese vat, after making rennet cheese, is run immediately into a vacuum pan, or in small factories into a large iron pan, 8 or 10 feet in diameter, and about 2 feet deep, and flat bottomed, The pan is made of smooth iron about ¼ to ⅜ inch thick, and has a hollow bottom about six inches deep, into which steam is run for heating the pan contents. The whey soon boils, and the escaping steam passes up through a wooden flue

through the roof. A large wooden hood over the pan connects with the flue. A cloth apron tacked to the edge of the hood hangs down around the pan, and can be raised when the workman is stirring the pan contents, etc.

Five thousand pounds of whey will require from 5 to 10 hours to boil down. About 20 pounds of steam pressure in the jacket is required at first, and toward the end a higher pressure to give the required temperature. A safety valve should be used.



Stirring Tub for Primost while cooling.

During the boiling, especially toward the end of the process when the material begins to thicken, the pan contents are stirred frequently to prevent sticking to the bottom, using a long handled iron hoe or scraper. When of the consistency of thin mortar, the steam is turned off, and the hot, mushy product is dipped with flat sided curd pails into a stirring tub, made of wood or of stainless steel, where the product is stirred as it cools, thus producing a fine grained, smooth, not sandy, mass of the consistency of thick mortar. The partly cooled mass is packed into well greased wooden cubes, such as are used for packing butter which is to be cut into pound prints. After standing until the product is fully cooled and hardened, it is cut up with a wire, and the blocks, weighing one or two pounds, are wrapped in tin foil, dipped in paraffine, and placed in cartons for the retail trade.

The acid developed in milk and whey during the making of American or similar cheese is of course present after the whey is boiled down and may impart more or less bitter or sour flavor,

which is partly overcome by neutralizing the whey with slaked lime down to .07-.08% acidity, and also by adding 10 or 15 per cent of brown sugar to the Primost in the boiling pan, just before dipping it into the stirring tub. Primost requires no curing, but sometimes becomes moldy on standing several months.

In the middle of the tub stands a hollow box, through which a shaft extends upward, carrying a cross beam at the top, from which four paddles extend downward into the tub. Either the tub or the paddles revolve about 80 times per minute, scraping down the Primost from the walls, and keeping it moving while cooling.

(308) Primost and Skim Cheese. To make both Primost and cheese from skim milk, add 1 or 2% of starter to the sweet skim milk, heat to 90 degrees, set with rennet so as to cut into cubes in one-half hour. Stir the curd in the whey (or it may be broken with a rake) for half an hour, allow to settle, and draw off the sweet whey into the Primost pan.

This method gets very sweet whey for Primost.

(308A) Primost as a Substitute for Sugar. This product keeps well, and when used in connection with glucose may replace a certain amount of cane sugar in candy making. Glucose, on account of its sticky physical condition, is hard to handle in the manufacture of candies, but a mixture of Primost, is much more granular and makes possible an increased use of glucose, in the manufacture of caramels and other candies. During a sugar shortage the use of this sugar substitute was found to be a matter of some economic importance.

(308B) Cheese Primost Spread. 100 lbs. of well cured cheese, finely ground, mixed with 30 lbs. primost by repeated grinding, forms an attractive spread, which is made and marketed by several firms.

CHAPTER XXXII.

BLUE VEINED CHEESE RIPENED WITH MOLD INSIDE

(309) The principal cheese varieties in this group are the French Roquefort, the English Stilton, and the Italian Gorgonzola. In France, Roquefort is made from sheep milk containing from 7 to 12% of fat, and 17 to 23% of solids. The milk is thickened with rennet in 1½ to 2 hours at about 80 to 90 degrees. The curd is cut and stirred, and after dipping out some whey, the curd is poured on a cloth to drain. The curd after draining is stirred well by hand, and finally filled into perforated forms, adding some portions of mouldy bread crumbs in the center of each cheese. The curd in the hoops drains three days longer in a warm room, and is then taken from the hoops to a cooler, dry room to dry the surface, turning daily for two or three days. It is then taken to the curing cellar, salted twice on the surface, and after three days more the slimy surface is cleaned with a brush, and the end is punctured many times with needles, making openings through which air reaches the interior of the cheese, to permit the growth of molds within. It is then taken to the curing shelves, in a cave at 90% humidity and 40 to 46 degrees F. About 4 months of curing are required, and they are then wrapped in tin foil. In America, good Roquefort cheese have been made from cow milk, by a very few factories. The cut surface is veined with blue mold, and the cheese has a characteristic, somewhat peppery taste. Mold cultures are offered for sale by The Dairy Laboratories, Philadelphia, and other firms.

Stilton cheese are made by somewhat similar methods, and English Stilton is packed in stone jars for export.

Gorgonzola is a blue veined cheese made in Italy.

The Roquefort mold is able to grow in an atmosphere containing much carbon dioxide and little oxygen, more freely than most other varieties, according to Thom, an American investigator. The Dairy Division, U. S. Dept. of Agriculture has demonstrated that cheese equal in quality to the imported Roquefort can be made from cow milk in the United States. In recent years, caves along the upper Mississippi riverbluffs and at other localities as at Faribault, Minn., Nauvoo, Ill., in Iowa, California, etc., have been used successfully for curing rooms. The products,

often called "blue" cheese are widely marketed in this country. U. S. D. A. bul. 970; Iowa State Col. bul. 324; Iowa Res. bul. 237, 283; California bul. 397.

Minnesota Roquefort from cow's milk is described briefly by Professor W. B. Combs as follows. The milk used should be clean and fresh, and should contain 3.8 to 4% fat. Three or four percent of starter is added, and acidity developed to .20-.23%. Three or four ounces of rennet per 1000 lbs. milk are added at 85-86, F. After standing 1 to 1½ hours, the curd is cut with knives into ¾ or 1 inch cubes. A few minutes after cutting, the curd is removed from the whey to a draining rack, where it is permitted to drain for 15 to 20 minutes. The curd is then placed in forms 6 inches high and 7⅜ inches in diameter, perforated with holes 3/32 inch in diameter, and 3/16 inch from center to center. As the curd is placed in the forms, it is sprinkled with spores of **Penicillium Roqueforti** previously grown on bread and dried. In the forms the curd drains 24 hours in a room at 68-72 degrees, F., and 85-90 per cent relative humidity. The forms are turned frequently during 24 hours. The cheese are then removed from the forms, placed on draining boards, and turned twice daily. After 3 to 5 days, the cheese are placed in a room at 48-50 degrees, F., and salted.

Salting is accomplished by rubbing salt on the cheese at the rate of 7.5 lbs. salt to each 100 lbs. of green cheese. At least three applications of salt are required. After salting, the cheese are pierced through with needles, which permits free access of air to the interior of the cheese.

The cheese are held in a room at 48-50, F., and at 95% relative humidity for about three months. At the University of Minnesota Experiment Station, large sandstone caves are used for holding cheese during this period. The cheese are then wrapped in tin foil, and placed at 45 degrees, F., for 3 to 6 months, until the characteristic flavor has developed. The ripened cheese is mottled with a blue-green mold especially luxuriant along the lines of the punctures made in the cheese. The flavor and aroma of the cheese are due principally to caproic, capric and caprylic acids or compounds formed from them, which are liberated from the milk fat in the cheese by the action of mold enzymes.

The acidity of blue cheese during curing has been studied at the Minnesota Station.

Experiments in curing cheese in an atmosphere of carbon dioxide have been conducted at the Washington State College of Agriculture, at Pullman, Wash.

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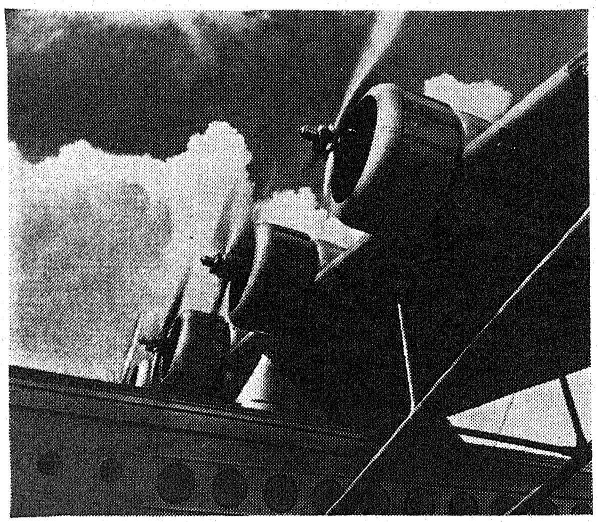


For Goodness Sake, Specify

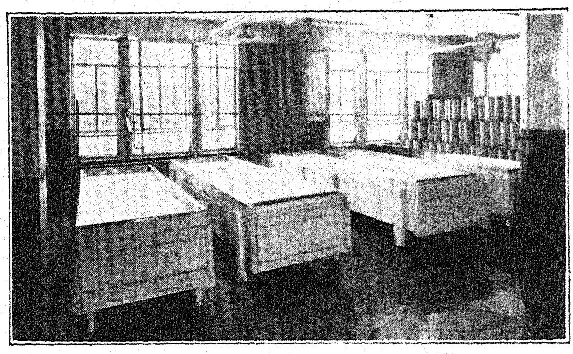
DIAMOND CRYSTAL SALT!

• To bring out the best in food products and to keep their quality always up to standard... be sure to specify Diamond Crystal, the salt that is regularly, scientifically tested for

UNIFORM COLOR... PURITY... DRYNESS ...SOLUBILITY... PRECISION SCREENING... CLEANLINESS... CHARACTER OF FLAKE

DIAMOND CRYSTAL SALT CO., INC.
St. Clair, Michigan

It Pays To Buy Creamery Package Cheesemaking Equipment and Supplies



Illustrated above is a battery of four CP UP-to-Date Cheese Vats in a prominent plant.

Whether you need a cheese vat, tinware, an agitator, a can washer, a pasteurizer, a curd rake or a complete refrigerating system, *you can get them all from one dependable source*—The Creamery Package Mfg. Company. Furthermore, when you buy from CP, you are dealing with the world's largest manufacturers of a complete line of dairy products equipment and supplies—a firm with a fifty year reputation for quality and dependability.

There's a CP branch near you—request a salesman to call, or write for Bulletin O-234 for complete information.

CP CHEESEMAKING EQUIPMENT AND SUPPLIES

Cheese Vats	Curd Forks and Rakes	Cheese Boxes
Cheese Presses	Tinned Steel Curd Knives	Cheese Bandages
Vat Linings	Wire Curd Knives	Cheese Cloths
Pasteurizers	Welded Cheese Hoops	Curd Mills
Agitators	Paraffining Tank	Perfection Gate Valves
	Plate Heat Exchangers	

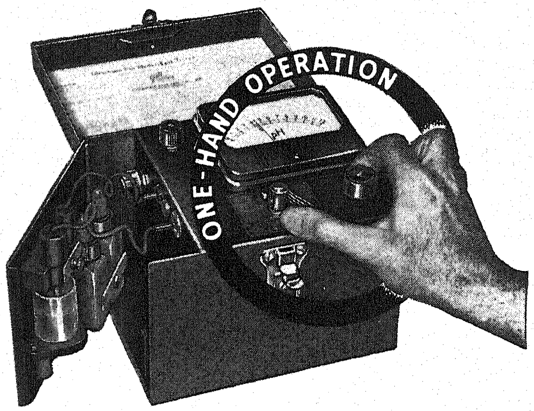
The Creamery Package Mfg. Company

General Office: 1243 W. Washington Blvd., Chicago

BRANCHES: ATLANTA, BOSTON, BUFFALO, CHICAGO, DALLAS, DENVER, DES MOINES, KANSAS CITY, MO., LOS ANGELES, MINNEAPOLIS, NEW YORK, OMAHA, PHILADELPHIA, PORTLAND, ORE., SALT LAKE CITY, SAN FRANCISCO, SEATTLE, TOLEDO AND WATERLOO.

CREAMERY PACKAGE MFG. CO. OF CANADA, LTD.
267 King Street, W. Toronto, Ontario

COLEMAN pH TESTERS
TO FIT YOUR NEEDS



MODEL 15. A rugged, modestly-priced pH meter, for routine service in the plant, accurate to 0.1 pH.

MODEL 3 SERIES. Fine, ultra-sensitive laboratory instruments, capable of measuring to an accuracy of 0.05 pH.

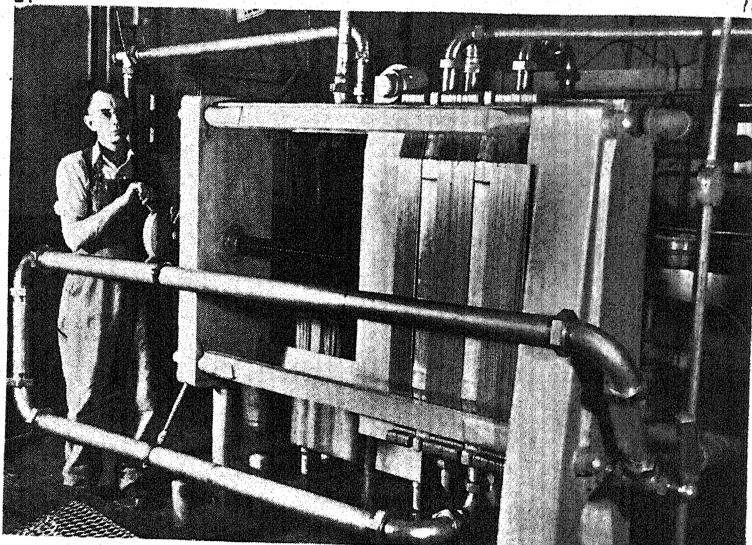
Choose from Coleman's *Superior Glass Electrode* **pH** *Electrometers*

Write today for full information covering our entire line

COLEMAN ELECTRIC CO., INC.

310 Madison St. Maywood, Ill.
122 E. 42nd St. New York, N. Y.

PASTEURIZED MILK ASSURES HIGH QUALITY CHEESE . . .



A 12,000 pound Cherry-Burrell Superplate Regenerative Type Pasteurizer which is being used with excellent results in a Wisconsin Cheese plant.

There are many Cherry-Burrell Superplate Regenerative Type Pasteurizers being used for pasteurizing milk for cheese making.

Everything about the Superplate's design and operation is simple. Adjustments are few. Cleaning is easy. It is flexible. The capacity of any model can be easily and economically expanded as desired. It can be used as a one-purpose unit or to combine several processes in the one press.

Plants, like the one shown, are producing cheese of greater uniformity — they are making very definite savings by increasing their yield. Find out about the Superplate. Send for copy of Bulletin G-382.

Cherry-Burrell Corporation

427 W. Randolph Street
Chicago, Ill.

"CHEESE SALT" is not CHEESE SALT

Real Cheese Salt is the product of scientific research and understanding.

More than ten years ago CHIPPEWA discovered a new Flake Cheese Salt.

Flakes, more porous, more delicate in structure than any known.

This salt followed no rules nor standards. It MADE them. It made new and *higher* standards. IT STILL DOES.

CHIPPEWA led the way to these higher standards in all the essentials of a correct Cheese Salt, viz.:

PURITY
(over 99.90% pure salt)

CLEANLINESS
(Chippewa was first to furnish salt free of extraneous matter)

QUICK SOLUBILITY
(Saves time, saves quality, insures against salt spots)

FLAVOR
(That is clean, pure, "sweet" and mellow)

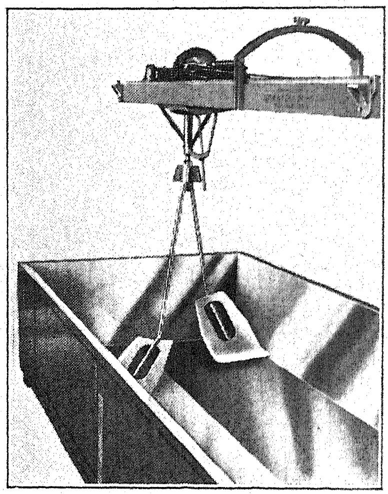
These standards will under no circumstances be reduced. They will be made *higher* if and when that becomes possible. This is our pledge.

THE OHIO SALT COMPANY

WADSWORTH, OHIO

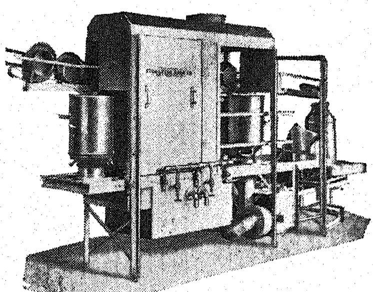
TISSUE CHIPPEWA SALT **FLAKE**

New Improved Stoelting Chainless Stirring and Forking Traveling Agitator



No slack or lost motion —you can start and stop this Stoelting agitator at any point in the vat. Quiet and fool-proof in operation — faultless in construction. Guaranteed uniform stirring and forking. This efficient new agitator is recommended by leading cheesemakers. Write for details.

STOELTING CAN WASHER



A highly efficient four can per minute Strait-Away washer carefully engineered for unfailing heavy duty service. The only low priced washer utilizing the outside wash water exclusively on the outside of the can. A money saving convenience that turns out dry sterile cans and is equipped with cover replacer and cover dryer. Used and recommended by leading cheesemakers.

STOELTING BROTHERS CO.

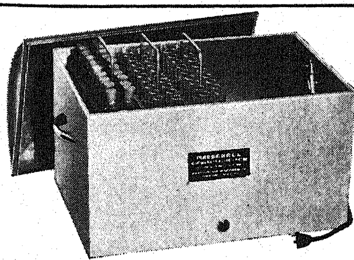
KIEL - - - - - - - WISCONSIN

MARSCHALL'S
America's Favorite Brand

FOR BETTER RESULTS IN CHEESEMAKING

MARSCHALL
Rennet Extract

A superior curdling agent, high in strength, always pure and uniform. Marschall superiority has been demonstrated over a period of more than 35 years.



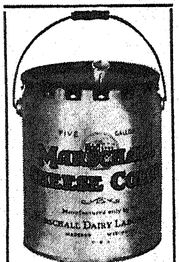
MARSCHALL
Methylene Blue Test

The Marschall Methylene Blue Test provides a practical and convenient method of grading milk. It readily detects bacteria laden milk.

The test is available in capacities for 60, 80, 100 and 120 samples.

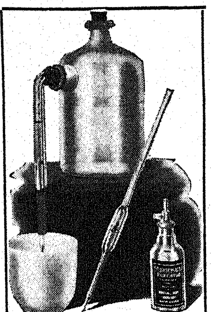
MARSCHALL
Rennet Test

Simple and convenient. Tells quickly and accurately when milk in the vat is ready to set.



MARSCHALL
Cheese Color

Made of the finest annatto. Pure, concentrated, uniform. Gives cheese that rich, appetizing market appeal. Convenient sizes for every user. A harmless vegetable coloring.



MARSCHALL
Acid Test

For determining the acidity of milk, cream and whey.

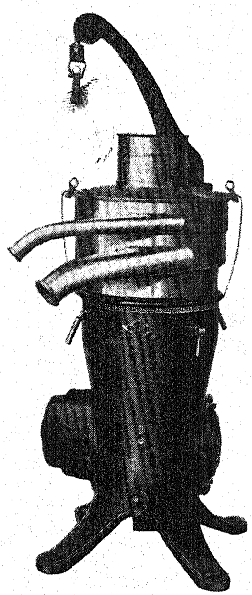
MARSCHALL DAIRY LABORATORY, INC.

MADISON, WISCONSIN

"World's Standard"

De Laval Separators

Whey Capacity 3,000 to 15,000 pounds



SKIMMING efficiency, mechanical perfection and durability all combined which means a saving in money, long life with extra years of satisfactory service, as well as a saving in time and trouble.

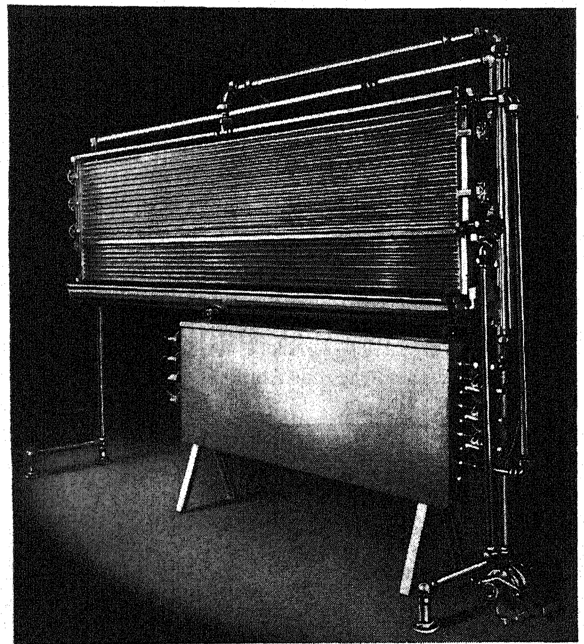
The De Laval all-purpose "World's Standard" possesses all of these and offers a saving of 30% in power, 75% to 90% in oil and up to 75% of fat losses, as compared with earlier types of separators which makes them well worthy of consideration. You get real value when you purchase a De Laval.

We shall be glad to give you full information upon request.

The De Laval Separator Co.

165 Broadway, New York 427 Randolph St., Chicago

CHESTER
REGENERATIVE PASTEURIZER



Designed Exclusively for the Cheese Factory

This pasteurizer is made by combining heating, cooling and regenerative units to suit the requirements of the cheese manufacturer. The type illustrated consists of a 1" regenerative section, a water cooling section and the New T H 6 — Tank Type Heater. Chester offers Regenerative Pasteurizers with capacities from 5,000 to 20,000 pounds per hour.

Write for New Bulletin

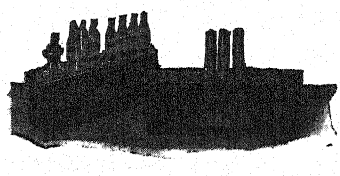
Chester Dairy Supply Co.

9th & Hyatt Sts., Chester, Pa.

LaMOTTE CHEMICAL CONTROL SERVICE

pH Outfits for milk, cheese, culture media and water.

Outfits for determining strength of washing and detergent solutions, chlorine sterilizing solutions, etc.



LaMOTTE BLOCK COMPARATOR

This compact, portable outfit greatly facilitates simple, accurate pH determination. Comes complete with full instructions. Price $12.50 F.O.B. Towson, Baltimore, Md.

LaMOTTE STERILIZATION TEST SET

For determining the free or available chlorine in solutions used to sterilize bottles and food containers, etc. Complete with full instructions. Price $6.00 F.O.B. Towson, Baltimore, Maryland. Full information on request.

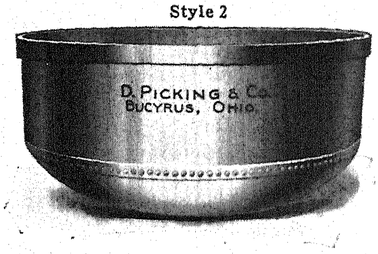
LaMOTTE CHEMICAL PRODUCTS CO.

(Originators of the Practical Application of pH Control)

Dept. CM Towson, Baltimore, Md.

Swiss Cheese KETTLES

Style 2



Made of heavy high-grade copper hammered to a smooth, bright finish.

ALL SHAPES AND SIZES

for wooden and brick steam Jackets.
Also steam Jacketed Kettles.

Send for Catalog and Prices.

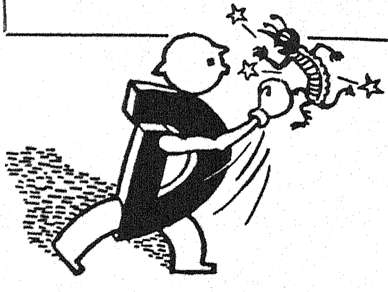
D. PICKING & COMPANY

Manufacturers of

All Kinds of Copper Kettles for 65 Years

BUCYRUS, OHIO

DIVERSEY PRODUCTS
FOR THE CHEESE PLANT



NOVEX . . .

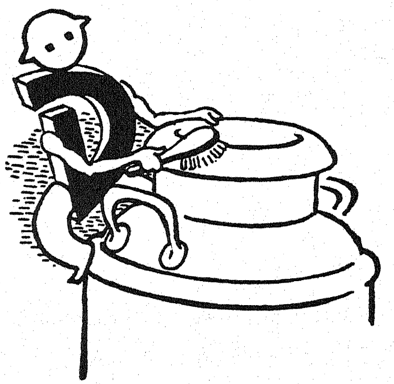
Keeps can washers operating efficiently and economically.

Novex is made to order for the can washer . . . it solves the problem of film coated, corroded milk cans and clogged, limed nozzles. A powerful, efficient cleaner, Novex softens hard water and protects the tinned surface against damage. Novex keeps the machine in tip-top condition as it consistently delivers clean, sweet-smelling cans.

DIVERSOL . . .

Quick acting crystal sodium hypochlorite — non-corrosive to equipment.

Diversol is ideal for disinfecting cheese making equipment, minimizing spoilage, off-tastes and flavors, and keeping everything in sanitary condition. The unique penetrating power of Diversol assures contact with bacteria. Diversol won't corrode or damage equipment. Dissolves instantly and completely. Softens hard water . . . leaves no film or scale. Diversol crystals will not lose their sterilizing strength.



D-LUXE . . .

The finest cleaner that money can buy — yet costs no more.

D-Luxe is the IDEAL product for the daily hand cleaning of cheese vats, sanitary pipes and fittings, tanks, and all other equipment. SUPERIOR water-softening action solves the problem of film-free cleaning even in the hardest water. With its powerful wetting action, D-Luxe "wets" the surface easily and gets a head start over ordinary cleaners. Unique cleaning power handles greasy, fatty matter, casein, soot, and similar stubborn dirt with ease.

DICOLOID . . .

The Diversey product for controlling milkstone. Safe, sure, economical.

Dicoloid will handle practically any milkstone condition. Stubborn contaminations are effectively removed from equipment without damage to the equipment itself.

PACKAGE GOODS . . .

Diversol, the non-corrosive disinfectant, is the perfect product for the farm. Helps prevent shut-offs, high bacteria counts and off-tastes.

Dumore is specially made and packed only for cleaning all farm milk utensils.

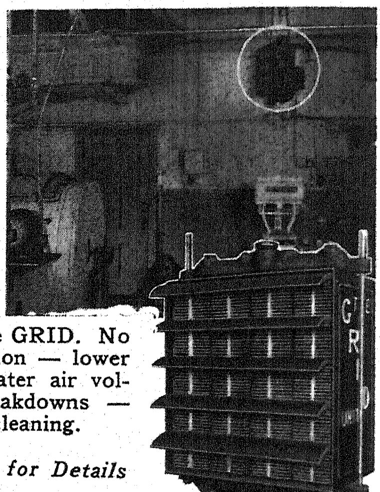
Dicoloid, the milkstone remover, is ideal to use on the farm for pails, cans and other equipment.

For complete information on these and other Diversey products write

THE DIVERSEY CORPORATION
53 W. Jackson Boulevard
Chicago, Illinois

PREVENT EXCESSIVE MOISTURE

INSTALL GRID UNIT HEATERS



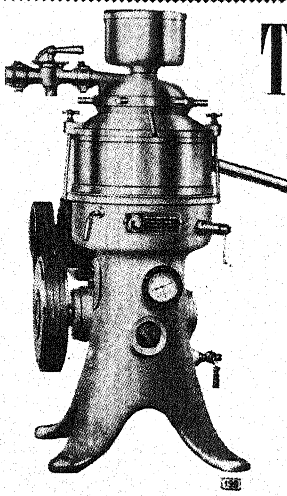
Equipment that does triple duty — heats and overcomes excessive moisture ever present in cheese factories — and eliminates fog conditions that result in molding of walls, that contaminates the finished product. At the same time produces ideal working conditions.

No other unit heater like the GRID. No electrolysis to cause corrosion — lower outlet temperature and greater air volume. No failures or breakdowns — self-cleaning.

GRID

Ask for Details

D. J. MURRAY MFG. CO. Wausau, Wisconsin



Triumphator Separator

Made in Switzerland

HIGHEST RECORDS
LOW COST
NEW FEATURES

Full Line of All Kinds of Domestic and Imported Swiss Cheese Equipment and Supplies.

ANGLIKER & MUELLER

Phone 817

Monroe, Wis.

Enjoy fly-free premises

by installing

DUROBAR ELECTRIC SCREENS

Flies are instantly electrocuted upon contact with DUROBAR-equipped doors and windows — before they reach food and become a factory nuisance.

Greater sanitary excellence, reduction in bacteria count and less contamination of cheese products are attained by the liberal use of DUROBARS.

An Ohio plant writes:

> "We have used Durobar electric fly screens for a number of years and last year bought some more for our swiss cheese plant. They are well worth while."

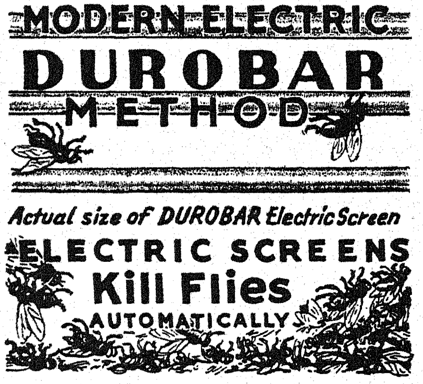
Write for valuable fly control information, details and prices.

NATIONAL ELECTRIC SCREEN CORP.

Dept. 17

CHICAGO

Offices in all Principal Cities



Leading Cheese-Makers

ENDORSE

FLAV-O-LAC FLAKES

●

And the list is constantly growing because this culture has demonstrated its dependability in producing *natural* flavor in making every type of cheese. It makes one of the most important steps in cheese-making a trouble-free, time-saving operation.

●

Flav-o-Lac Cheese Culture Flakes are used for making better quality Cottage, Cream, Neufchatel, Cheddar, Camembert, Roquefort, Swiss and all special cheeses.

We also supply Flav-o-Lac mold cultures.

Send for Booklet
See our Catalog in Dairy Industries Catalog File.

The Dairy Laboratories

MAIN OFFICE: PHILADELPHIA, PA.
Branches: New York - Baltimore - Washington
Pioneers in Vitamin Assays. Inquiries Invited.
(Vitamin "D" Excluded)

A DIVISION OF
DALARE
ASSOCIATES

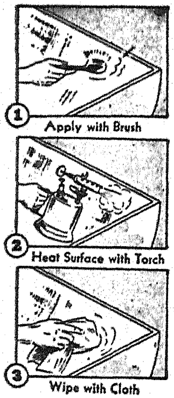
Everything for the

Swiss, Italian, Brick, Limburger Industry

Our Manufacture Includes:

Vats, Tanks, kettle jackets, Press tables, Salt tables, Cheese lids, stirring apparatus, hand or motor driven, *Swiss cheese cloth*, Hoop rope, Dairy brushes (hand made) Swiss cheese hoops, Aluminum scoops, cheese knifes, Incubators, Cellar equipment, Brick boxes, Limburger boxes, Swiss cheese tubs. *We are equipped to make* any special equipment or tool, according to your pattern or design. We cordially invite you to visit us.

DONNY CHEESE FACTORY EQUIPMENT CO.
Monroe, Wisconsin



TIN YOUR VATS

cans, cheese hoops, by the Quick, Simple Low-Cost

MELTOMATIC WAY

USE MELTOMATIC PASTE TIN.

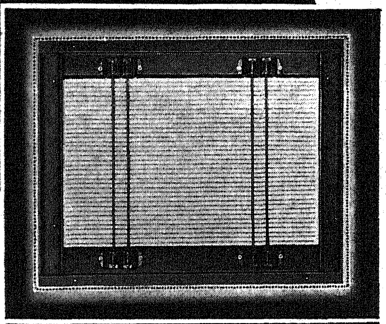
Or, for soldering or retinning use Meltomatic Paste Solder Trial Offer — Send us $3.00 or your form order for a 2 lb. can of Meltomatic Paste Tin and we will include a Free Sample of Meltomatic Paste Solder, both postpaid.

If you are not entirely satisfied — you may send back the unused portion for full credit.

WAYNE CHEMICAL PRODUCTS CO.

9765 Copeland St. . . . Since 1898 . . . Detroit, Michigan

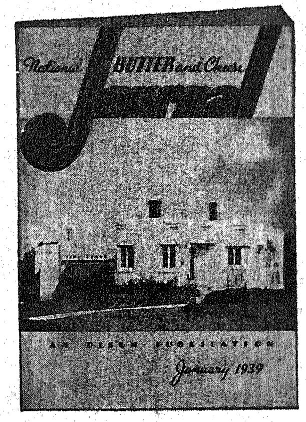
Electrified Fly and Insect Screens by Cesco carry an unconditional guarantee of satisfactory service



Mounted on your present window or door screens, an efficient, economical Cesco screen will operate continuously in all kinds of weather without care or attention. A Cesco all metal screen will give years of service—will definitely relieve your fly problem. Hundreds are in use everywhere—many in food industry plants. Write now for factual folder.

Chicago Electric Scientific Co.
2300 W. Warren Blvd., Chicago, Ill....

The Favorite Business Paper of the Butter and Cheese Industries



Devoted to the problems of manufacturing and marketing butter and cheese. Each issue is packed with interesting articles and helpful information on various phases of processing, quality control, merchandising, and news of the butter and cheese industries. Subscription price: $1.00 for one year, or $2.00 for three years, in the United States, payable in advance.

THE OLSEN PUBLISHING COMPANY

505 West Cherry St., Milwaukee, Wis.

SAVE

Fuel — Boiler Repair — Boilers

With Our 40 Years Experience,

we analyze raw boiler waters and prepare boiler compound (water treatment) to suit needs of the water, to remove old scale and prevent new scales from forming. Send us a quart sample of your raw boiler water for free analysis, or ask us to send a container.

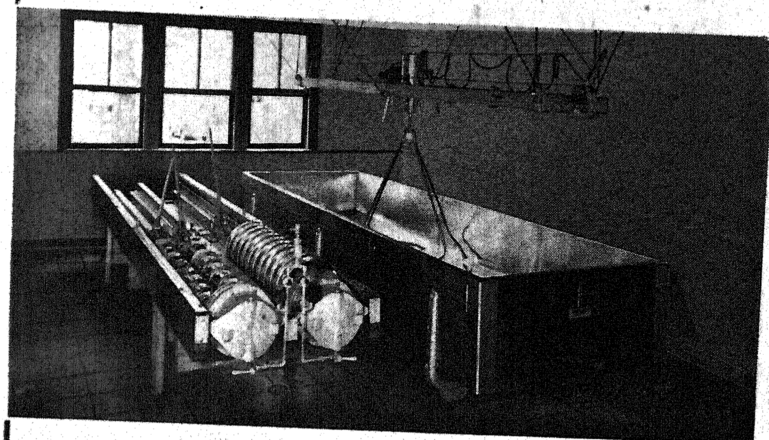
SUHM COMPANY, INC.

1942-50 S. Kinnickinnic Ave. **Milwaukee, Wis.**

BEFORE YOU BUY...

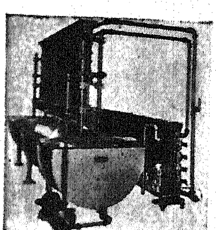
Consult DAMROW

"MANUFACTURERS OF QUALITY EQUIPMENT THAT COSTS LESS TO OWN"

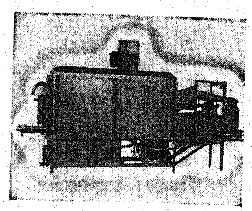


This model cheese making combination includes the new Damrow Hydraulic Cheese Press.

DAMROW *Complete*
DAIRY EQUIPMENT . . .
FOND DU LAC • WISCONSIN



Damrow Regenerative Pasteurizer



Damrow Can Washers